Coal Age

1957

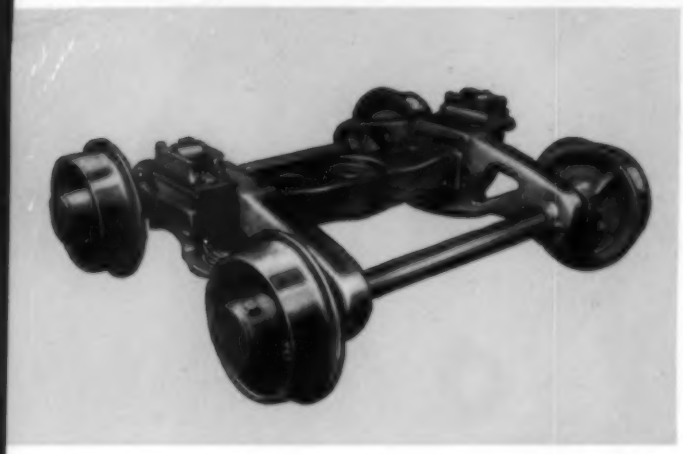
MINING GUIDEBOOK

AND

BUYING DIRECTORY

ISSUE

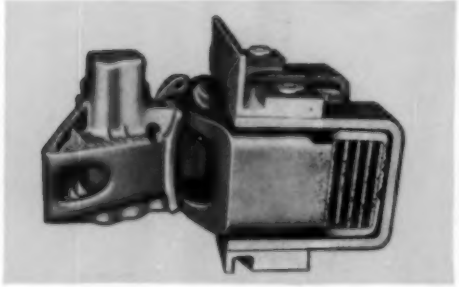
MID-JULY, 1957 A McGRAW-HILL PUBLICATION PRICE $1



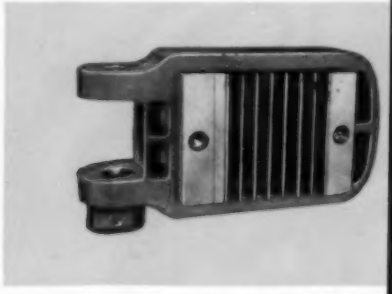
NATIONAL equipment cuts per-ton costs

NC-1 MINE CAR TRUCK is the latest example of National's pioneering in better equipment. Among NC-1 truck advantages are longer and softer ride springs, friction damping mechanism that controls vertical and transverse oscillations, automatic frame alignment and cast one-piece bolster with large lubricated center bearing. AA-25

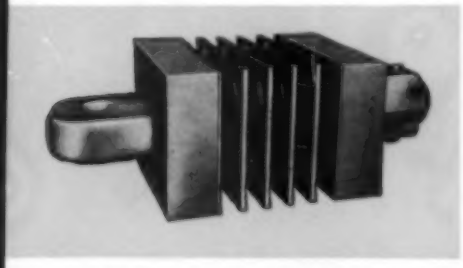
WILLISON AUTOMATIC COUPLERS save time with maximum safety, couple at either end of car or locomotive, require no manual assistance, eliminate damaging slack, permit high speeds with maximum stability.



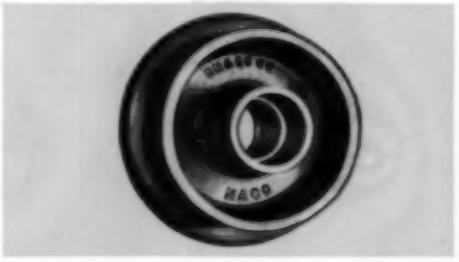
NATIONAL MI-235 Rubber-Cushioned Draft Gear primarily used in Willison spherical-horn coupler assemblies for drop-bottom cars and locomotives; are effective with link and pin bumpers and in strap yokes.



NATIONAL MI-225 Rubber-Cushione Draft Gear for locomotives and larg capacity cars not required to opera through rotary dump. Give maximu impact protection in minimum spac

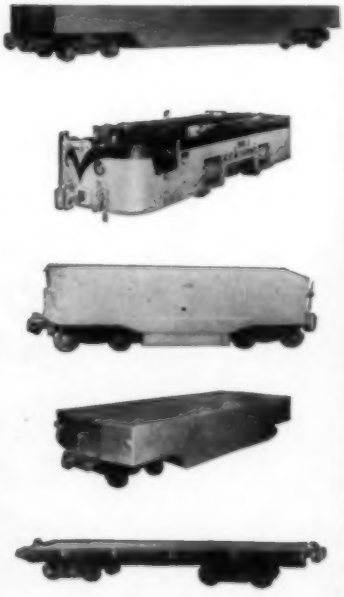


NATIONAL MI-230 Rubber-Cushioned Draft Gear for cars in rotary dump service. High-capacity rubber pads with soft initial action provide maximum impact protection, lengthen equipment life. Available in capacities and designs to fit individual requirements.



NACO STEEL WHEELS, made from quality-controlled Naco cast steel—of high yield point, great tensile strength and ductility—reduce tread spalling or flange breaking. Available in all sizes regularly used in mining or industrial operations.

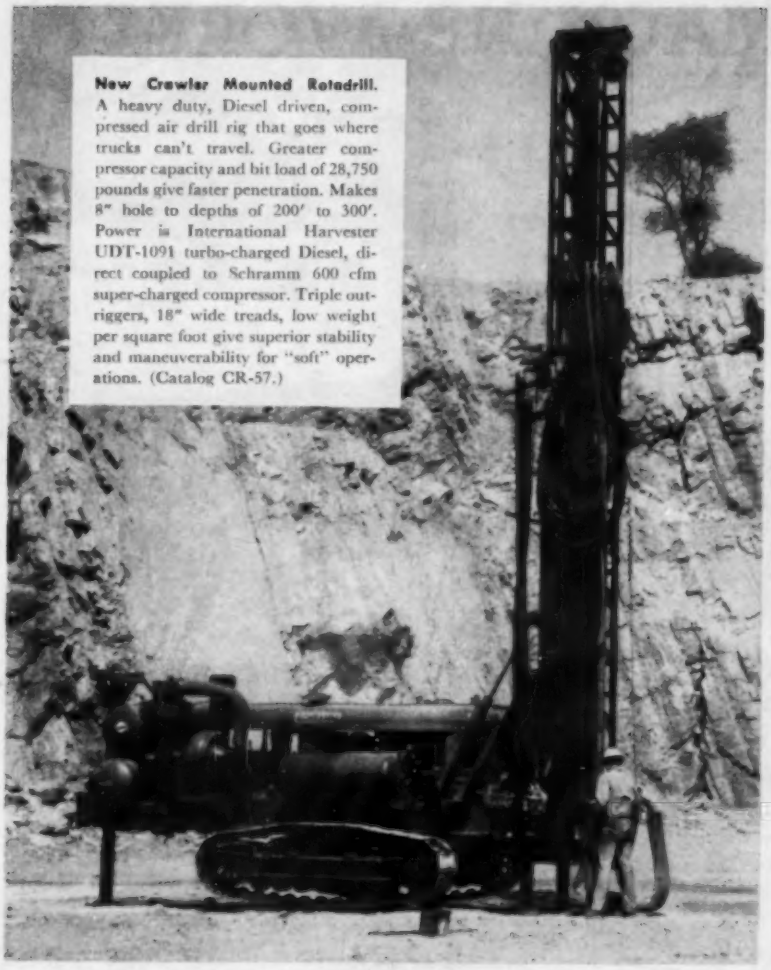
Over 100,000 Willison Automatic Couplers have been installed in cars and locomotives engaged in mining operations, industrial plant hauling and foreign railway service.



NATIONAL MALLEABLE AND STEEL CASTINGS COMPANY • Cleveland 6, Ohio

Technical Center

"Progress through Research"



New Crawler Mounted Rotadrill. A heavy duty, Diesel driven, compressed air drill rig that goes where trucks can't travel. Greater compressor capacity and bit load of 28,750 pounds give faster penetration. Makes 8" hole to depths of 200′ to 300′. Power is International Harvester UDT-1091 turbo-charged Diesel, direct coupled to Schramm 600 cfm super-charged compressor. Triple outriggers, 18" wide treads, low weight per square foot give superior stability and maneuverability for "soft" operations. (Catalog CR-57.)

Truck Mounted Diesel Rotadrill. Separate UD-1091 International Diesel engine drives compressor, hydraulic pumps, dust collector, etc. You get the economy of Diesel drilling without the expense of a Diesel powered truck. (Catalog TMA-56.)

Pneumatractor Rotadrill. A 125 cfm air compressor and self-powered drill rig. Makes 4½" hole to a depth of 500′ with 10,000 pounds down pressure. Operates efficiently at 15 psi, yet pressure can be instantly increased for dewatering or breaking out blockages. (Catalog PR-56A.)

SCHRAMM AIR DRILLING EQUIPMENT FOR EVERY MINING NEED

Three Schramm Rotadrills—crawler-mounted, truck-mounted and Pneumatractor-mounted—provide a complete line of coal drilling equipment. They are self-contained, self-propelled drill rigs for the larger, deeper holes. The Pneumatractor with drill and rotary sweeper fills the need of the strip miner. Portable compressors, stationary compressors and air tools are available for drilling with existing rigs.

Schramm, Inc.

MANUFACTURERS OF AIR COMPRESSORS

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STANDARD PNEUMATRACTOR DOES TWO IMPORTANT JOBS...

Rotary Brush Attachment, mounted on forward end of Schramm Standard Pneumatractor with Pneumafeed, cleans the surface of the coal vein after shovels have removed major part of overburden. For complete information on the Standard Pneumatractor, write for free copy of catalog 5745.

Deluxe Pneumafeed, mounted on Schramm Standard Pneumatractor, is a self-propelled, self-powered wagon drill, capable of drilling at a distance of 9′ from the center post. It can drill vertically and at any angle or horizontally from 12′ above to 3′ below the ground level.

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BALDWINSVILLE, N. Y.

Builders of Centrifugal Pumps and Hydraulic Dredges Since 1864

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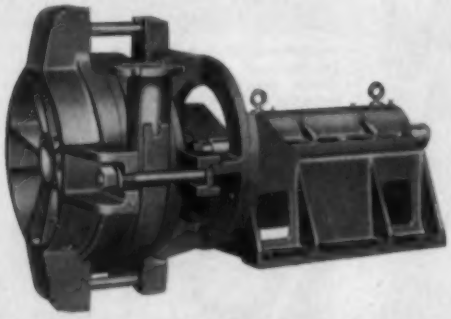
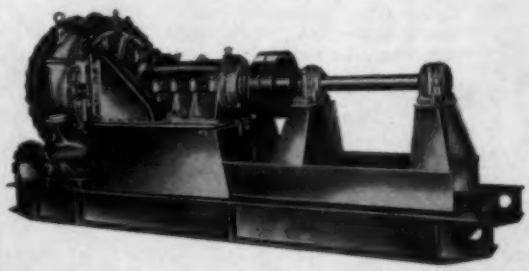


MORRIS type "RX" SLURRY PUMP

. . . for continuous 24-hour pumping of **Ore Slurries, Tailings, Concentrates, Abrasive Mixtures.**

- **Simple design.** No internal studs or bolts—no troublesome internal joints and fits.
- **Easily dismantled.** Impeller and shaft sleeve reached simply by removing 4 external bolts.
- **Abrasive resistant.** Casing furnished in large variety of wear-resistant materials.
- **Large hydraulic passages.** Permit low velocities, minimizing wear and frequency of renewals.
- **Drive-side suction.** Stuffing box troubles practically eliminated under conditions of high suction pressure, high vacuum or high suction lift.

Widely used in both metallic and non-metallic mines and mills. Sizes 2" to 8". Write for Bulletin No. 185.



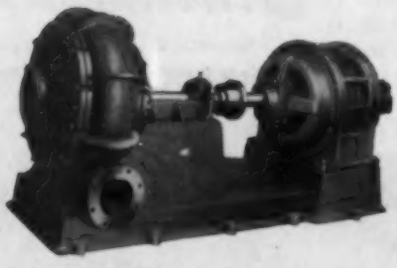
MORRIS type "GA" and "GAF" HEAVY DUTY DREDGE PUMPS

Small high speed or large low speed units for pumping abrasives against high heads.

- **Giant shaft** of high-grade steel withstands vibration, handles shock loads easily.
- **Suction opening** is larger than discharge for handling higher percentage of solids at greater depths without excessive vacuum on suction.
- **Oversize antifriction bearing assembly.**
- **Economical impeller design.** With external cleaning vanes on both sides. Enlarged suction shroud seals on nose.
- **Heavy volute casing** with extra heavy sections at points of maximum wear. Discs covered with heavy renewable liners . . . openings are of same size for right or left hand assembly.

Wearing parts furnished in special alloys. Sizes: 6" to 36". Send for Bulletin No. 184.

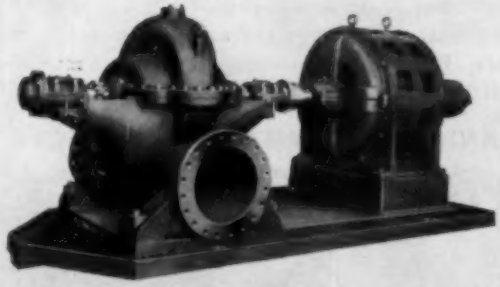
MORRIS



MORRIS Type "M" Material Handling Pump

The Standard Pump in Many Mines for Coal Cleaning

- **Low speed, wide clearance** for continuous low-wear non-clog solids pumping at lower cost.
- **With heads of 120'** or less, will handle solids ranging from fine abrasives to pieces of 11" diameter.
- **Most important wearing parts** receive least wear, are subdivided for easy replacement of parts where greatest erosion occurs.
- **High mechanical and hydraulic efficiencies** are maintained throughout longer service period.



MORRIS Double-Suction Horizontally-Split Centrifugal Pump

For Drainage and General Service

- **Floating Sealing Rings** adjust concentrically to impeller speeds.
- **Extra-heavy shaft** of tough, hard alloy steel.
- **Upper part** of horizontally-split casing easily removed without disturbing suction or discharge piping.
- **Heavy-duty, precision ball bearings** mounted in dust- and moisture-proof housings.

May be connected in series for higher heads. Sizes: 2" to 220". Send for Bulletin No. 179.

Coal Age

MID-JULY, 1957

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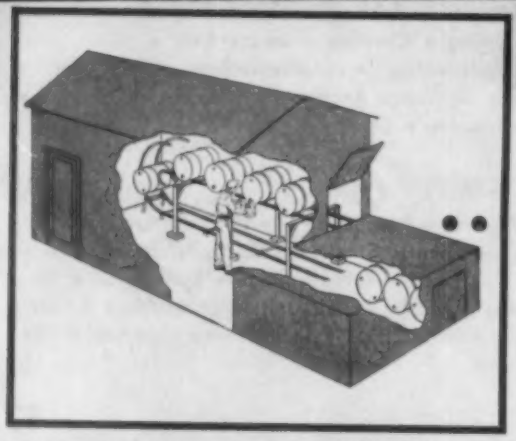


This type of oil storage house simplifies the handling problem. Filled drums are moved directly from the loading platform to the light gage mine rails above; empty drums are rolled onto lower rails and stored under the loading platform. Storage house should be of fireproof construction and kept clean at all times.

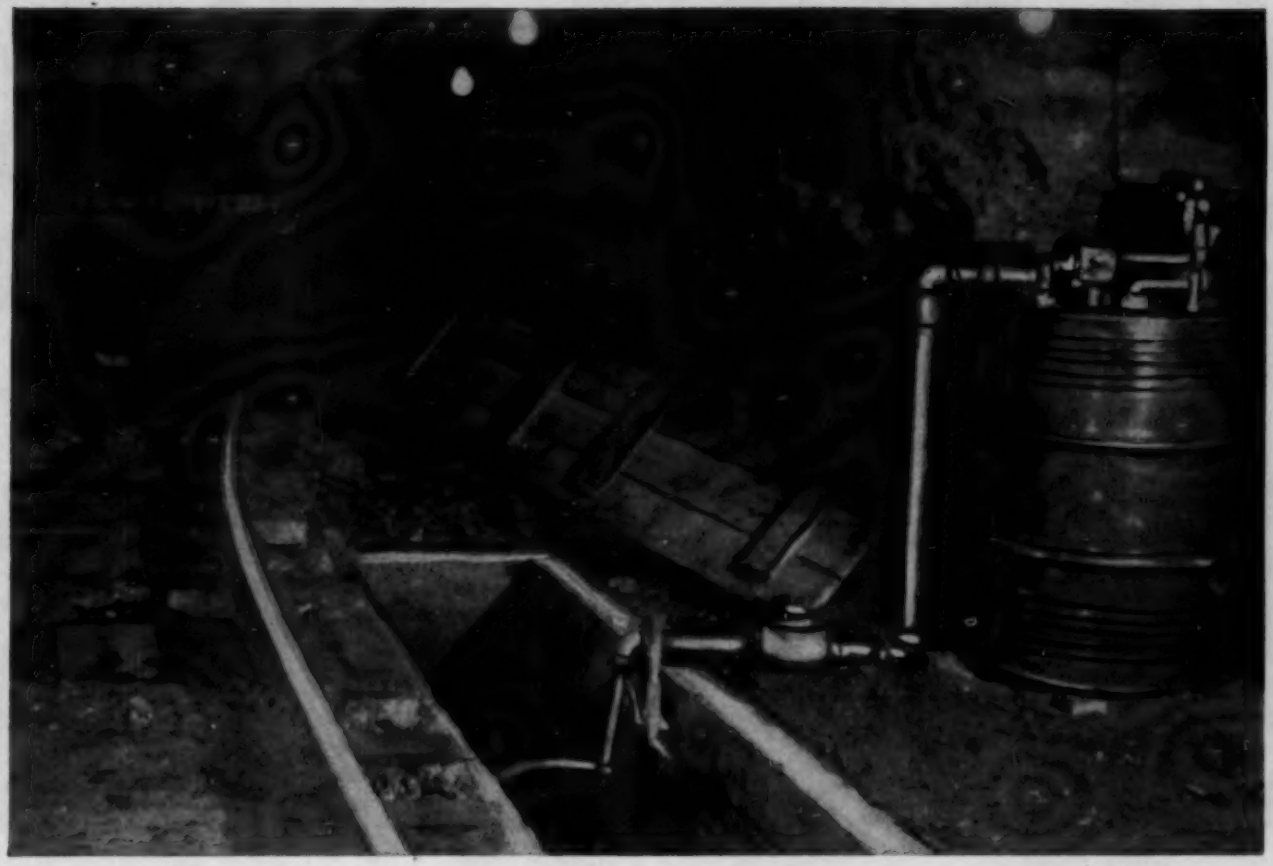
. . . starting point

Lubrication is an important item in your mine's operating budget. That's why you should give oils and greases the same special storage and handling care you give renewal parts.

A central storage house of the type shown here can help you prevent waste and contamination . . . protect lubricants from water, dust, dirt and other foreign matter. Moreover, it simplifies handling because it eliminates the need for expensive hoisting equipment and lifting from one level to another.

TEXACO

TEXACO



for lower tonnage costs

Your Texaco Lubrication Engineer can help you set up the most efficient system for your mine. He has had experience with central, outside and underground storage and handling systems.

He can also reduce your inventory by suggesting a few versatile lubricants...*Texaco Multifak*, for example. This lubricant protects all the grease-lubricated bearings in motors, locomotives, cutters and loaders from dust, rust and wear. Thus, it reduces lubricant inventory and minimizes the chances of mistakes.

For wire ropes and open gears, use *Texaco Crater* or *Texaco Crater X Fluid*. Both keep wire rope strong longer... give gears smoother operation and longer life.

Your Texaco Lubrication Engineer has had special training in mine equipment lubrication. To contact him, just call the nearest of the more than 2,000 Texaco Distributing Plants in the 48 States, or write:

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A CONSTANT STANDARD OF QUALITY
in everything you need for drilling rock

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HYDRA-BOOMS. Available with extendable and non-extendable features and with hydraulic power cone, dump and swing.

SEND FOR BULLETIN NO. 4162

WAGON DRILLS . . . the "workhorses" of rock drilling. Available in two drill mountings: Heavy-duty FM-4 and lightweight "wagonjack."

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SHORT-LEG STOPER. Lightweight and easy to handle, the I-R Short-Leg Stoper is designed *specifically* for low-cost rock bolting.

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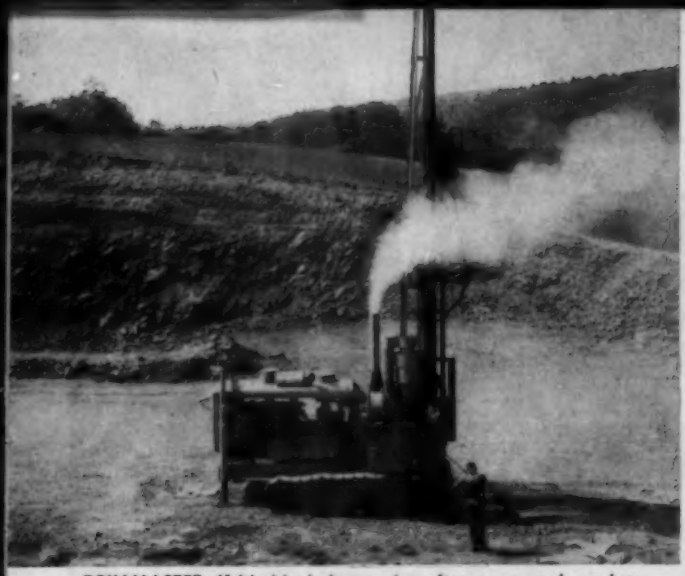

DRILLMASTER. If it's big holes you're after, on a real production basis, you can't buy a more productive drilling machine than the I-R Drillmaster.

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SHAFT JUMBOS. I-R Hydra-Boom Shaft Jumbos save set-up time, drilling time, manpower.

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CRAWL-IR. Here in one rugged package is self-propelled crawler drill with *all* boom and feed-tower adjustments controlled hydraulically.

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STATIONARY COMPRESSORS...by Ingersoll-Rand are heavy-duty machines built to give you continuous full-load service.

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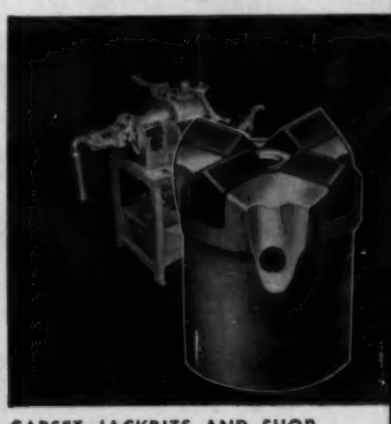

CARSET JACKBITS AND SHOP EQUIPMENT...a complete line of Carset Jackbits, bit and rod shop equipment.

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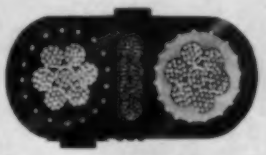
Parallel Duplex (Flat Twin) Mining Machine Cable—600 Volts
(Ungrounded or grounded)

Single-Conductor Locomotive Gathering Cable—600 Volts

Portable Power Cables—Two, Three and Four Conductors
(Ungrounded up to 3,000 Volts, or grounded up to 5,000 Volts)

Three-Conductor Mine Power Feeder Cable
(Shielded with ground wires up to 10,000 Volts)



Rome's shuttle car cable can't be damaged by bending

The rugged Neoprene jacket forms a resilient web between insulated power conductors and ground conductor for maximum impact resistance. The open braid on each conductor firmly interlocks conductors to the sheath as a sturdy integral unit. A greater number of finer strands in power and ground conductors—plus a closely woven fibrous covering around the ground conductor (to minimize mechanical working of the fine strands)—increase over-all flexibility. These two features, together, prevent the damage that constant flexing, twisting, and tension might otherwise cause.

Vulcanized in lead for extra toughness

Rome 60 mining cables are built for rugged duty, both above and below ground

These tough Rome cables have a much longer service life than ordinary cables. This is of dollars-and-cents importance to you because it can mean less down time, reduced replacement expenses, and increased production.

Here are some of the construction features that make Rome 60 cables your best mining cable buy:

Conductors. All conductors are of finely stranded copper wires for maximum flexibility.

Insulation. A long-aging, heat- and moisture-resistant rubber compound permits operation at 75° C., thereby providing overload protection. For high-voltage service, an ozone-resistant insulation is used.

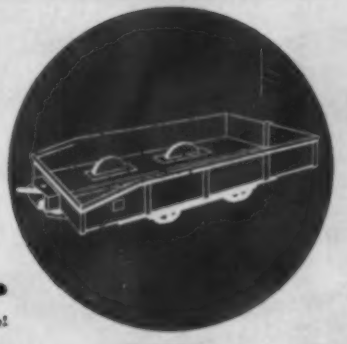
Reinforcements. On Rome 60 portable cables, a heavy reinforcing open braid locks the Neoprene jacket to the inner construction to prevent failure from twisting, pulling, flexing and sheath separation.

Jacket. Neoprene vulcanized in a continuous lead mold provides durability and high resistance to abrasion, acids, oils and flame. All Rome 60 mine-trailing cables are surface-molded "P-105 BM" indicating full compliance with Federal and State of Penn. safety codes.

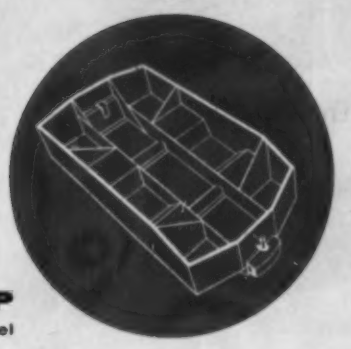
Specify Rome 60 mining cables for your next job. Contact your nearest Rome Cable representative for more information—or write to Department 176, Rome Cable Corporation, Rome, New York.

ROME CABLE
CORPORATION

DROP BOTTOM
4 wheel or 8 wheel



END DUMP
4 wheel



ROTARY DUMP
4 wheel or 8 wheel

acf MAKES ALL THREE TYPES

No matter what type of car your mining operations call for **acf** has a car to fit your needs. **acf** mine cars are built in all types and sizes from 2 to 30 tons, or more.

For safety, low maintenance and high speed constant haulage all **acf** mine cars have special features developed through many years of experience in design and manufacture.

Anti-friction bearings in the load-support wheels permit safe high speed from loading point to unloading point and back again for more. Automatic couplers make car handling safer and faster. **acf** double-action spring bumpers lower maintenance on everything from trackage to locomotive... provide smoother, safer hauling.

For complete information about the full line of **acf** Constant Haulage Mine Cars in all sizes and types contact the nearest **acf** sales office or discuss your haulage problems with one of our sales representatives.

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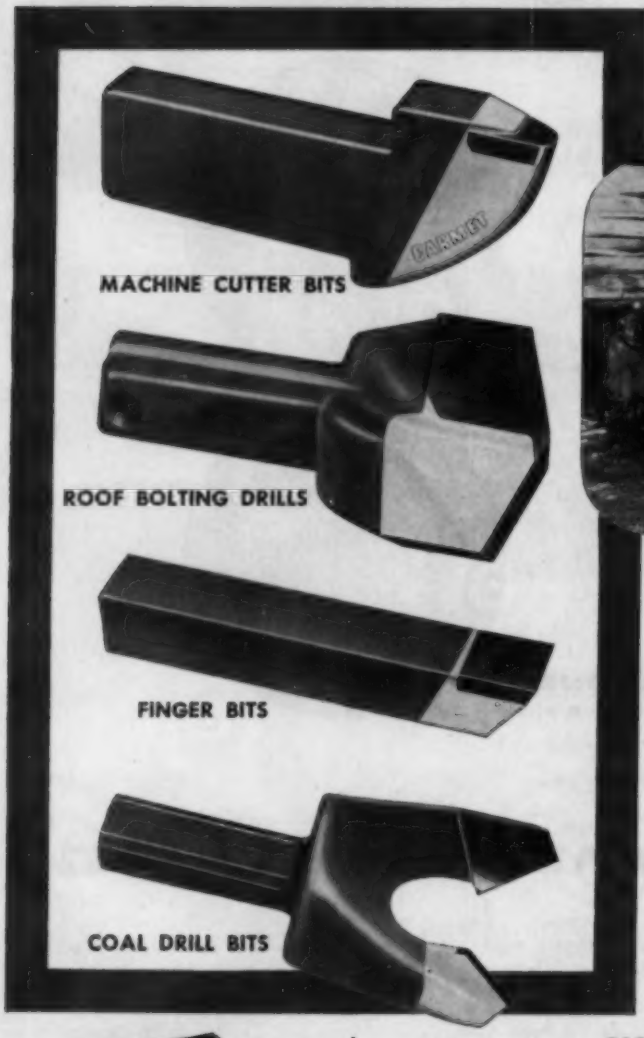
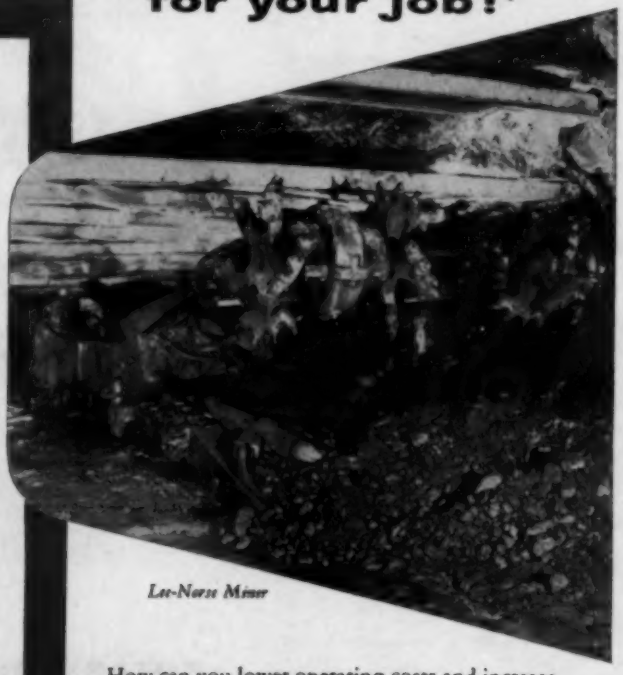
Choose the right mining tool bit

for your job!





Lee-Norse Miner

How can you lower operating costs and increase tonnage?

One way is to make sure you're getting all you should from your mining tool bits . . . that they're right for the job they're supposed to do . . . and that they are suited to your particular mining conditions.

These are matters your Carmet Distributor, with the aid of a Carmet mining engineer (they are located in every major coal mining area in the country), can advise on. Ask his help in establishing a complete mining tool control program. *Allegheny Ludlum Steel Corporation, Carmet Division, Detroit 20, Mich.*

Write for your copy of the CARMET MINING TOOL CATALOG and METHODS MANUAL

Illustrates full line of Carmet mining bits . . . giving tool dimensions, rake and clearance angles, etc. Specifies grinding wheels and procedures for reconditioning tool bits.

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McCombs Supply Co., Jellico, Tennessee
Oglebay, Norton Mine Supply Div.,
Offices: St. Clairsville, Ohio;
Charleroi & Johnstown, Pa.
Persinger Supply Co., Williamson, W. Va.
Persinger's Inc., Charleston, W. Va.
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EDISON R-4 ELECTRIC CAP LAMP—Brilliant, unfailing beam gives miners the light they must have to work mechanized equipment at its greater capacity, safely. Rugged construction provides dependable service shift-in, shift-out, for years. **EDISON PERMISSIBLE ELECTRIC TRIP LAMP**—Illumination at every angle. High wattage provides great visibility. **M-S-A MINE LIGHTING SYSTEM**—U.S. Bureau of Mines Approved. Cuts down accidents, increases coal output. Provides dependable lighting with instant start circuit that is safe under any and all conditions of ventilation in gaseous mines.

Edison R-4 Electric Cap Lamp

Edison Permissible Electric Trip Lamp

M-S-A Mine Lighting System

COMMUNICATIONS

M-S-A MINEPHONE—Sends dispatcher's orders instantly and simultaneously to all motormen, who can receive and reply while trips are in motion. This clear, two-way voice communication keeps trips moving, minimizes waits on sidings. Repair needs are relayed in seconds. Over-all safety is improved because one message alerts all personnel at once.

M-S-A MinePhone keeps haulage in step with mechanization.

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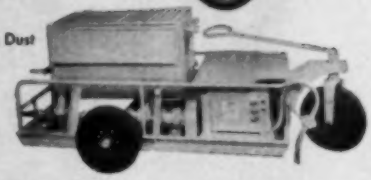
M-S-A BANTAM 400 ROCK DUST DISTRIBUTOR—Discharges 30 lbs. per minute through 400 ft. of hose, or 100 lbs. per minute through 25 ft. of hose. Available now as self-propelled unit. Low height makes it ideal for low coal application and for transporting on any belt or pan conveyor with 16-inch clearance. Also used for fire fighting and wet dust application. **M-S-A SLURRY ROCK DUST DISTRIBUTOR**—With one 400 lb. batch of slurry you can rock dust 80 linear feet of mine entry with this machine. Takes four minutes to mix slurry. Tank capacity is 42 gallons. Discharges 80 lbs. per minute through 600 feet of hose.

M-S-A Bantam 400 Rock Dust Distributor

M-S-A Slurry Rock Dust Distributor



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M-S-A METHANE ALARM—Continuously samples air at working face. Flashing red light warns miners of hazardous concentrations. Automatic; portable; can be mounted. **M-S-A METHANE RECORDER**—Continuously charts methane concentrations in return air. Accurate safety check against unusual gas conditions. Serves as guide for regulating volume of air to maintain proper and economical ventilation standards. Records, and gives visual and audible warnings. **M-S-A—WOLF JUNIOR FLAME SAFETY LAMP**—Dependable, steady flame, guarded by improved ventilation. Easy-to-read graduated chimney. **M-S-A METHANE DETECTOR W-8**—Instant, accurate reading of methane. Ideal for spot checking. Light; portable. **M-S-A METHANE TESTER TYPE M-6**—Pocket sized unit. Indicates methane as low as .2%.

M-S-A Methane Alarm

M-S-A Methane Recorder

M-S-A—Wolf Junior Flame Safety Lamp

M-S-A Methane Detector W-8

M-S-A Methane Tester Type M-6

When you have a safety problem, M-S-A is at your service. Our job is to help you.

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SAFETY EQUIPMENT HEADQUARTERS
MSA

tonnage output with increased safety

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M-S-A SELF-RESCUER—Emergency breathing protection against carbon monoxide, smoke. Light; comfortable. Individual carrying case or cache assembly for underground storage. **M-S-A DUSTFOE #66 RESPIRATOR**—Light; compact. Approved breathing protection against dusts. Maximum vision. **M-S-A CHEMOX**—Complete breathing protection in any atmosphere. U. S. Bureau of Mines Approved. Generates own oxygen supply from replaceable chemical canister. Light (13½ lbs.). **M-S-A McCAA TWO-HOUR**—Ideal for rescue work, fire fighting. Complete breathing protection for minimum of two hours. Now available with full facepiece. U. S. Bureau of Mines Approved.

M-S-A Self-Rescuer

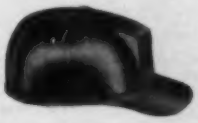
M-S-A Dustfoe #66 Respirator

M-S-A Chemox Oxygen Breathing Apparatus

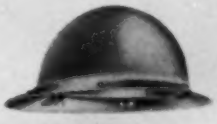
M-S-A McCaa Two-Hour Oxygen Breathing Apparatus

HEAD PROTECTION

M-S-A COMFO CAP—Combines light weight with complete head protection. Low crown design for low coal mining. Well balanced; durable. **M-S-A GLASS FIBER HAT**—High pressure molded for strength; smooth contours deflect falling objects. Available in red, white, yellow, green, blue, gray, black.



M-S-A Comfo Cap



M-S-A Glass Fiber Hat

FIRST AID EQUIPMENT

M-S-A UNIT FIRST AID KITS—Complete assortment of Unit "D" package dressings. Each package wrapped in cellophane. Steel case. **M-S-A EMERGENCY FIRST AID OUTFIT**—For storage at working face. Contents selected to provide aid for practically every mining emergency . . . kits, splints, stretcher, blankets, etc. **M-S-A MINER'S FIRST AID CABINET**—Supplied with medical dressings and equipment for mine hospital or dressing station use.

M-S-A First Aid Kits

M-S-A Emergency First Aid Outfit

M-S-A Miner's First Aid Cabinet

ARTIFICIAL RESPIRATION

M-S-A PNEOLATOR—Completely self-contained artificial respiration device. Supplies oxygen under intermittent positive pressure, automatically. **M-S-A PULMONARY VENTILATOR**—Effective intermittent positive pressure for the treatment of many respiratory disorders. Provides complete respiratory tract distribution of aerosols.

M-S-A Pneolator

M-S-A Pulmonary Ventilator

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M-S-A MINE FIRE TRUCK—Designed for mobility and fast hook-up. Lets you fight fires fast. Rugged, low-slung, all steel. 5-inch treads for easy maneuverability. Painted bright yellow enamel. Combination fog and straight stream nozzle is standard equipment. Top of tank contains storage capacity for 800 feet of 2-inch M-S-A Fire Hose.

M-S-A Mine Fire Truck

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GREASE GUNS (Heavy Duty Steel Construction)
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Empties 55 gal. drum of S.A.E. 30 oil in two minutes.

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Heavy Duty, spring actuated.

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Complete Combinations of Pumps and Hose Reels. Standard Groups or Custom-Built Rigs.

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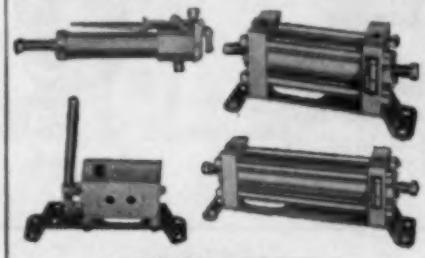
Complete Systems for Original 400 lb. Drums, or 5 gal. Packages.



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For Injecting Metered Quantities of Lubricant on Assembly Lines.

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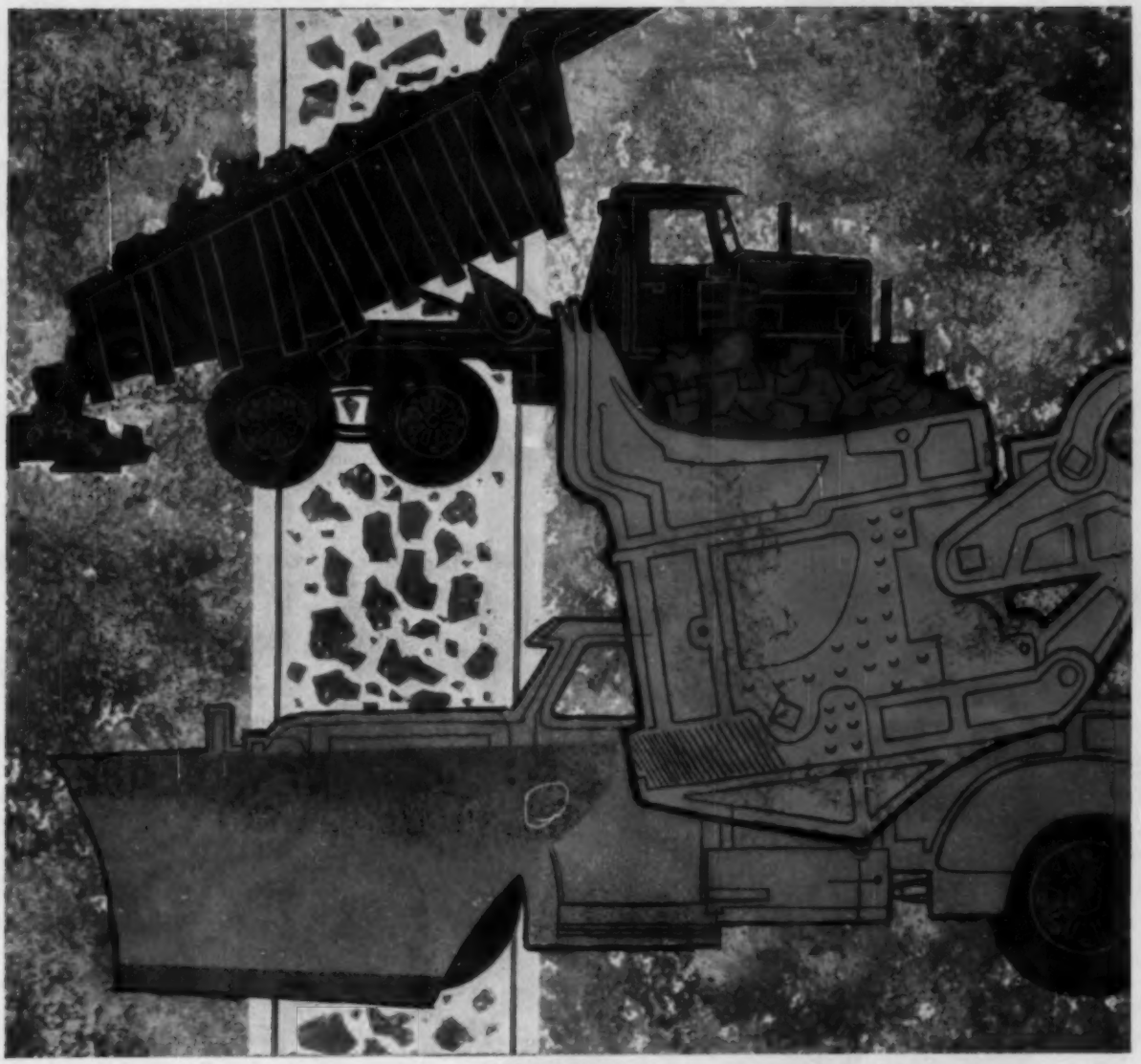

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resists impact and abrasion in toughest applications

Heat treated Jalloy steels wear as much as 20 times longer than mild steels under rigorous impact and abrasive conditions. By using Jalloy you can cut maintenance costs drastically. Increased product life reduces downtime and lowers your labor costs.

Jalloy steels are available in the forms you require (plates, hot rolled sheets, hot rolled bars, small shapes and structurals). Jalloy can be purchased in three grades to meet specific use requirements: Grade 1, where formability is important; Grade 3, capable of being heat treated to excellent physical properties for good resistance to abrasion or wear; Grade 7, where high hardness with good ductility or wear resistance is desirable.

Your local distributor can supply you with latest information on these Jalloy grades, or you can write to Jones & Laughlin Steel Corporation, Dept. 411, 3 Gateway Center, Pittsburgh 30, Pa.

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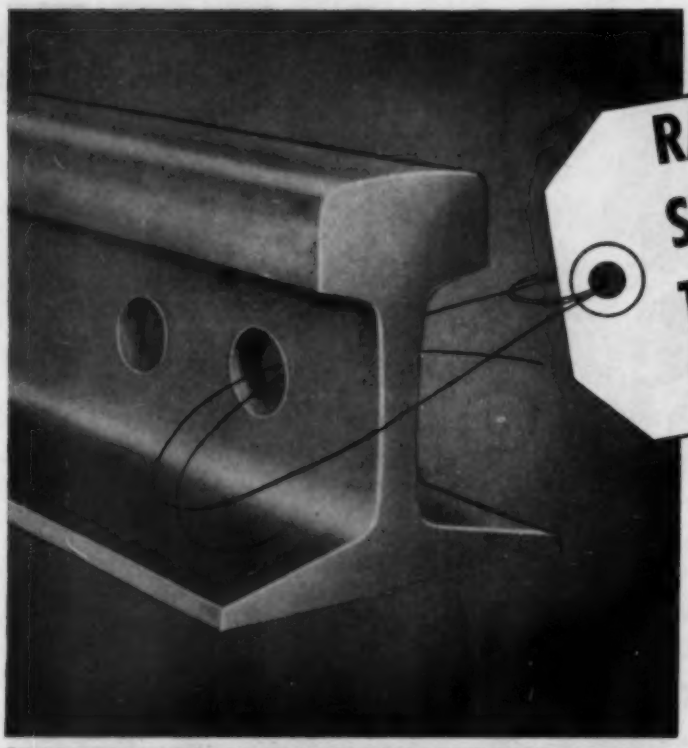
...a great name in steel



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ALL SIZES, ALL WALLS
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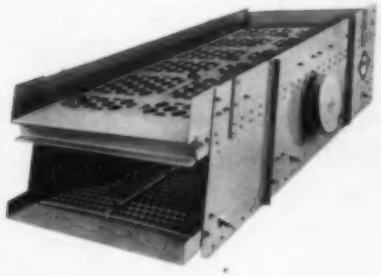
Allis-Chalmers is leading supplier of **VIBRATING SCREENS** for coal

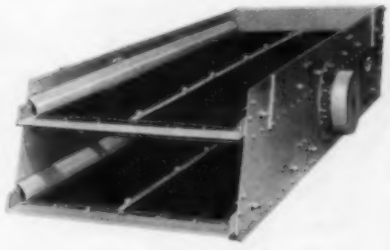
Turn Page for Screen Selection Guide



Model XH *Ripl-Flo* Inclined Screens

For scalping and coarse sizing

Heavy steel construction . . . balanced two-bearing mechanism. Available with wire cloth, perforated plate surfaces. Maximum feed size 24 inches. 1, 2 or 3 decks. Bulletin 07B6151.



Model SH *Ripl-Flo* Inclined Screens

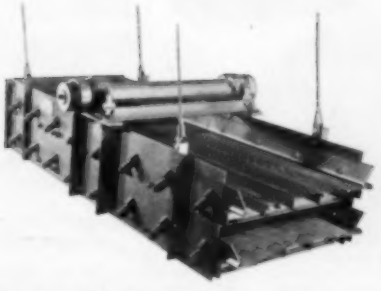
For light scalping, coarse to fine sizing, wet or dry and rinsing

Screen has balanced two-bearing mechanism . . . designed for wide range of applications. Available with wire cloth, perforated plate surfaces. Maximum feed size 8 inches . . . 1, 2 or 3 decks. Bulletin 07B6151.

Model S *Ripl-Flo* Inclined Screens

For moderate to fine sizing, wet or dry

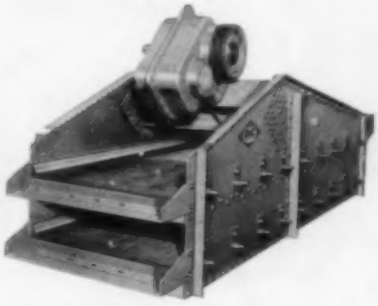
Sturdy low cost screens . . . have two-bearing mechanism. Available with wire cloth or perforated plate surfaces . . . maximum feed size 6 inches . . . 1, 2 or 3 decks.
Bulletin 07B8229.



Model AVS *Aero-Vibe* Inclined Screens

For moderate to fine sizing, wet or dry

Top screening efficiency at lowest possible cost. Screen has two-bearing mechanism located above body. Available with wire cloth or perforated plate surfaces. Maximum feed size 6 inches . . . 1, 2 or 3 decks.
Bulletin 07B6099.



Low-Head Horizontal Screens

For coarse to fine sizing, wet or dry, rinsing, thickening, dewatering and media recovery

Horizontal operation saves head room. Convenient mechanism above body imparts straight line motion to screen. Available with wire cloth or perforated plate surfaces. Maximum feed size 8 inches . . . 1, 2 or 3 decks. Bulletin 07B6330.

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ALLIS-CHALMERS CAR SHAKERS unload hopper bottom railway cars in minutes . . . big savings in manhours and demurrage costs. Eliminates necessity for men to enter cars. Motor and drive are within the shaker body, protected from weather. Fits all U. S. standard hopper bottom cars. Bulletin 07B7221.

ALLIS-CHALMERS

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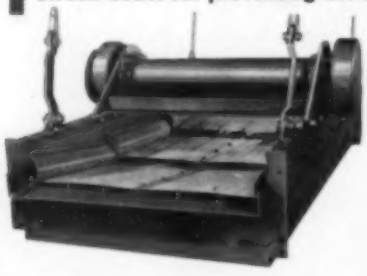
vibrating screen SELECTION GUIDE for coal preparation plants

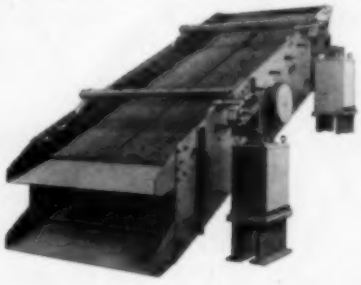
APPLICATION	MAX. FEED SIZE	APERTURE RANGE	SCREEN	COMMON SIZES
Scalping ROM Coal & Rock ahead of Crushers or Picking Tables	24 in.	3 to 10 in.	Model XH	4 x 10 to 6 x 16 ft.
Dry Sizing Raw Coal ahead of Cleaning Units	8 in.	4 Mesh to ½ in.	Model SH **1** and **2**	4 x 10 to 6 x 16 ft.
	6 in.		Model S	3 x 6 to 4 x 10 ft.
Wet Sizing Raw Coal ahead of Cleaning Units	8 in.	28 Mesh to ½ in.	Model SH	4 x 10 to 6 x 16 ft.
	6 in.	28 Mesh to ½ in.	Model S	3 x 6 to 4 x 10 ft.
	5 in.	48 Mesh to ½ in.	*Low-Head*	3 x 6 to 6 x 20 ft.
	⅜ in.	⅜ in.	Model SH **3**	4 x 10 to 6 x 16 ft.
			Low-Head	3 x 6 to 6 x 20 ft.
	¼ in.	20 Mesh	Model SH **3**	4 x 10 to 6 x 16 ft.
			Low-Head	3 x 6 to 6 x 20 ft.
Sizing and Dewatering Coarse Coal after Cleaning Units	8 in.	¼ to 4 in.	Model SH	4 x 10 to 6 x 16 ft.
	5 in.	¼ to 3 in.	*Low-Head*	4 x 10 to 6 x 20 ft.
Wet Sizing Middlings after Cleaning Units	8 in.	¼ to 1½ in.	Model SH	4 x 10 to 6 x 16 ft.
	6 in.		Model S	3 x 6 to 4 x 10 ft.
Sizing Fine Coal after Dry Cleaning Units	1¼ in.	28 Mesh to ⅛ in.	Model S	3 x 6 to 4 x 10 ft.
	1¼ in.		Model AVS	3 x 6 to 4 x 10 ft.
Dewatering Refuse after Cleaning Units	8 in.	20 Mesh to ½ in.	Model SH	4 x 10 to 6 x 16 ft.
	6 in.		Model AVS	3 x 6 to 4 x 10 ft.
	5 in.		*Low-Head*	4 x 10 to 6 x 16 ft.
Media Recovery after Heavy Media Cleaning Units	8 in.	½ MM to 1½ MM	*Low-Head*	3 x 12 to 8 x 20 ft.
Dewatering and Desliming Fine Coal after Cleaning Units	½ in.	⅛ MM to ½ MM	*Low-Head*	3 x 12 to 6 x 20 ft.
Sizing Washed and Crushed Coal	1½ in.	⅜ to ⅜ in.	Model SH	4 x 10 to 6 x 16 ft.
	1½ in.		Model S	3 x 6 to 4 x 10 ft.
	1½ in.		Model AVS	3 x 6 to 4 x 10 ft.
Solids Recovery	¼ in.	⅛ MM to 20 Mesh	*Low-Head*	3 x 6 to 6 x 16 ft.
			Model S	3 x 6 to 4 x 10 ft.
			Model AVS	3 x 6 to 4 x 10 ft.

1 screen decks for preventing binding



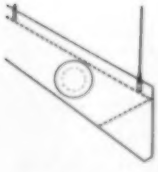
For moist material. *Tri-Slope* deck screens moist ¾ x 0, ½ x 0, and ¼ x 0 material. Higher capacity than conventional deck because of differential conveying rate. Also used with *Thermo-Deck* Heating Unit or *Sta-Kleen* deck. Bulletin 07B6151.

For wedge-shaped material. *Sta-Kleen* deck consists of a ball retaining deck below the screen cloth . . . small compartments contain oval balls. Screen vibration causes balls to bounce between retaining deck and cloth dislodging material that wedges into apertures of cloth. Bulletin 07B8354.

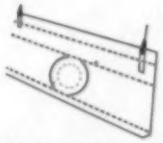


For moist material. *Thermo-Deck* Heating Unit permits screen to operate without shutdown to clean screen. Heat distribution to cloth is uniform. Low voltage, high amperage resistance heating controlled by tap switch mounted on dry-type transformer. Also used with *Sta-Kleen* deck. Bulletin 07B7812.

2 screens for sizing raw coal

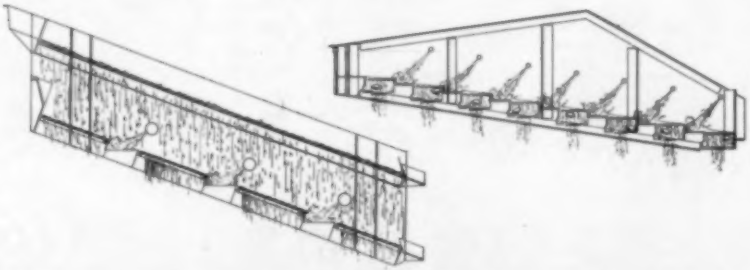


Screens with sloping and reverse angle bottom plates save head room and permit use of smaller hopper.



Multiple deck screens (different slope on each deck, depending on feed size and separation required) enable removing oversize lumps on top deck, egg or range size on second deck, nut size on bottom. Bulletin 07B6151.

3 screen decks for wet sizing raw coal



Pool washing screens utilize water sprays directed to washing pools in screen deck. Washing process puts fines into suspension for passage through screen surface . . . increases screening capacity, saves water. Bulletin 07B8214.

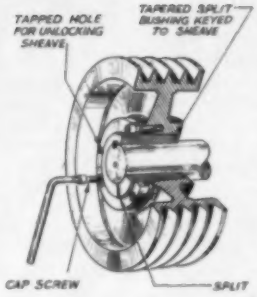
Vibrating screens are available with dust enclosures, water-cooled mechanisms, automatic stop control, and can be either floor mounted or cable suspended.

A DRIVE FOR EVERY MACHINE

***Texrope*—greatest name in V-belt power transmission—is the registered trademark of Allis-Chalmers, originator and pioneer of multiple V-belt drives.**

Ask for Bulletin 20B6051, "Handy Guide to Selection of *Texrope* Drive Equipment"; it tells the complete *Texrope* Drive story . . . V-belts . . . sheaves . . . and how to figure a *Texrope* drive.

MAGIC-GRIP SHEAVES

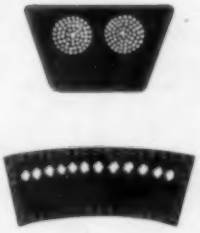


The *Magic-Grip* cast iron sheave is designed for fast, easy mounting and demounting. Construction is simple, foolproof. Sheave can be installed or removed in shortest possible time. Cuts *maintenance* costs—reduces "down" time to minimum. It automatically adjusts itself to slightly oversize or undersize shafts. Positive clamp fit on shaft means no weaving—no vibration. There is no back lash—no extra play. Sheave can be mounted closer to motor or machine—reducing strain and stress. Result: bearing pressure *eased*—bearing life *increased*.

Entire sheave is smoothly finished, firmly fastened. Constant tension on cap screws means they won't work loose. Stock sizes for drives up to 200 hp. Larger sizes available on order.

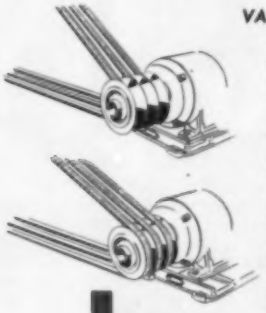
Bulletin 20B8407.

TEXROPE V-BELTS



Famous patented grommet construction provides longer life than ordinary V-belts. Made with straight sides for greater grip. Types for all operating conditions: heat-resisting; oil-resisting; static-resisting and special High Capacity. Also available: *Texrope* wide range V-belts for use with wide range *Vari-Pitch* sheaves and *Vari-Pitch* Speed Changers.

VARI-PITCH SHEAVES AND SPEED CHANGERS



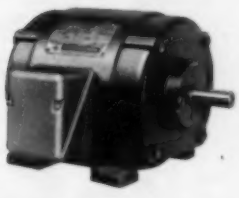
VARI-PITCH SHEAVES are available in two types; Standard Range for A, B, C, D or E belts—capacities from 1 to 300 hp—speed variations up to 40%. Wide Range for Q and R belts—capacities from 1½ to 40 hp—speed variations up to 100%. Both types designed with stationary or motion control features—Stationary Control for infrequent changes when sheave is stopped; Motion Control for repeated speed changes while sheave is in motion. Bulletin 20B6082.

Vari-Pitch Speed Changers furnish 3¾ to 1 speed ratio in one compact, enclosed unit. Adjustable while in motion. Combines two wide range, worm gear-adjusted sheaves. Manual or pushbutton control

Bulletin 20B6013.

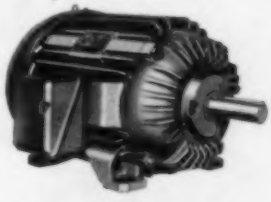
MOTORS FOR EVERY DRIVE

Allis-Chalmers builds a *complete* line of polyphase squirrel cage, wound rotor, synchronous, and direct current motors with electrical and mechanical modifications to meet *any application*. Ask for Bulletin 51B6052, "Handy Guide for Quick Selection of Electric Motors"; it furnishes you with enough facts on Allis-Chalmers motors to enable you to select the type which meets your required electrical and mechanical specifications. The next time you need an electric motor, contact your nearby Allis-Chalmers representative.



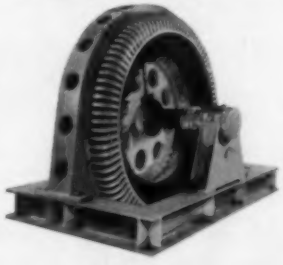
DRIP-PROOF

Small, tough, general purpose squirrel cage motors. All-around protection of inner parts. ½ to 200 hp and up. Also in splash-proof types. Bulletins 51B6210 and 51B7693.



ENCLOSED FAN-COOLED

Protected from dust, grit, vapor, gases. Cooling air circulated around exterior. ½ to 100 hp. Bulletin 51B7225. Also in new tube cooled type to 3000 hp. (51B7150).



SYNCHRONOUS

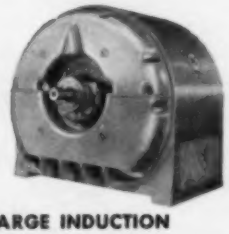
High torque motors of constant speed, available in ratings of 40 hp and larger. End shield bearing types, Bulletin 05R-8183; pedestal bearing types, 05B7648, 05B7649; engine type 05B8008.

CONTROL FOR EVERY MOTOR

Allis-Chalmers makes a line of starters to meet practically all motor control needs. Count on this wide range of starters, backed by industry-wide application engineering experience, for the answer to your control needs. Ask for Bulletin 14B7988

WOUND ROTOR

For adjustable varying speed service. High starting torque, low starting current. Bulletins 51B6052 and 05R8183.



LARGE INDUCTION

Drip-proof or splash-proof. 60 hp at 300 rpm to 2000 hp at 1800 rpm. Bulletin 05B7542. Ped. bearing types, 05B7771.

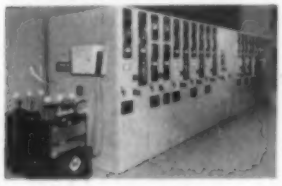
POWER AND ELECTRICAL EQUIPMENT

As a leading manufacturer of both steam and hydraulic power plant equipment, Allis-Chalmers is in a position to fill your complete requirements for turbines, generators, condensers, pumps, control equipment, etc.

And for power distribution, A-C has transformers, motor-generators, converters, rectifiers, metal-clad switchgear, switchboards, indoor and outdoor circuit breakers, etc.

TRANSFORMERS

From the largest power transformers to instrument and metering transformers in a wide range of types and ratings. Dry-type transformers from 3 to 12,000 kva for installation right at load centers. Sealed dry-type available for mine use. Transformers also available with *Chlorextol* non-inflammable liquid for mounting indoors or on roofs.



SWITCHGEAR

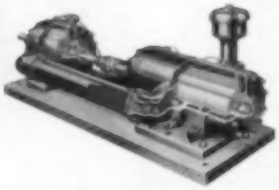
High and low voltage metal-clad and metal enclosed switchgear in all standard ratings to suit your particular requirements. Breakers for HV switchgear can be either oil or magnetic air types. LV switchgear uses either manually or electrically operated air breakers. Weatherproof switchgear is available for outdoor installation. Switchboards built to suit, in standard or duplex types.

UNIT SUBSTATIONS

Completely factory built, unit substations can be installed indoors or out to provide power where you want it . . . to reduce cable costs and line losses . . . to provide better regulation. A-C substations can be built with any combination of HV and LV switchgear and oil, air or *Chlorextol* liquid cooled transformers to suit application. They can be equipped with rectifiers for reliable dc supply. Bulletin 11B6285 for load center units and 11B6935 for outdoor multi-circuit units.

BLOWERS - COMPRESSORS

Centrifugal blowers are compact, light weight units with only one moving part. Four types available. Motor or turbine drive. Capacities to 130,000 cfm, pressures to 35 lb G. Bulletin 16B6048. Multi-stage blowers also available. Bulletin 16B6104.



Single-stage *Ro-Flo* compressors for pressures to 50 lb gauge, and volumes from 42 to 3245 cfm. Two-stage units in 12 sizes for 250 to 1800 cfm, 60 to 125 lb gauge. Single and two-stage *Ro-Flo* vacuum pumps to 0.3 in. Hg abs., 5950 cfm. Bulletins 16B8244 and 16B8126.

CENTRIFUGAL PUMPS

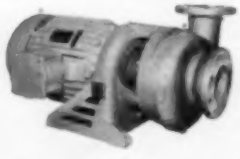
More than 60 years' experience in designing and building centrifugal pumps goes to work for you when you specify Allis-Chalmers. This engineering background is your assurance of the *right* pump for your job! Whether your application calls for a single-stage or multi-stage pump, a pump to handle clear liquid, corrosive or abrasive liquids, or liquids containing high percentages of suspended solids, contact A-C for the *one* pump that will meet your particular requirements. Ask for "Handy Guide to Centrifugal Pumps," Bulletin 52B6059, for the story on the complete A-C line.

COAL WASHING PUMPS

Developed by Allis-Chalmers especially for coal washing, the CW Solids pump handles up to 40 percent solids in suspension in slurries, tailing and sludges. Hundreds of applications have proved their economy.

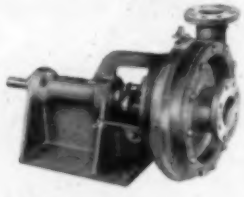
Casing and working parts are made of a special, highly abrasion-resisting alloyed iron. Pump parts last longer . . . continue to deliver near rated capacity until completely worn. Rotating element can be removed without disturbing piping arrangements. Simplified design means easy maintenance—entire pump can be dismantled, worn parts replaced, and pump reassembled and back in operation in as little as ½ hour. Comparable size units of different ratings have interchangeable parts.

Built in eight sizes from 4 x 3 to 16 x 14 inches. Capacities from 175 to 10,000 gpm, heads through 140 feet. Through speed variations alone, A-C Solids pumps give the widest head and capacity range of any unit on the market. Bulletin 52B6381.



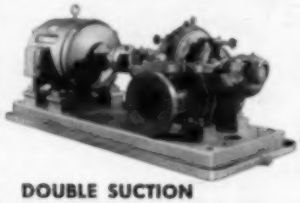
CLOSE COUPLED

With adapter between pump and motor to permit choice of motor sizes and types to meet practically any condition. Pump and motor operate on single shaft. Capacities 10 to 2500 gpm, heads to 550 ft. Bulletin 52B6083.



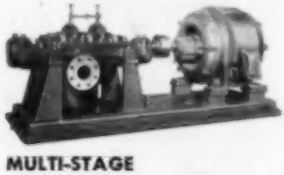
FRAME MOUNTED

Pump mounted on frame with separate shaft. Hundreds of standard ratings available, varying from 1 x ¾ to 8 x 6 in. Capacities from 10 to 2000 gpm, heads to 500 ft. Grease or oil lubricated. Bulletins 52B6351 and 52B7638.



DOUBLE SUCTION

Single-stage for general water supply, circulating or drainage. Coupling has *Magic-Grip* bushing for easy dismantling or assembly. 66 sizes from 2 x 1½ to 18 x 16 in. Capacities 30 to 7000 gpm, heads to 475 ft. Bulletin 08B6146.



MULTI-STAGE

Single or double suction for clear liquids against high heads. For mine pumping, boiler feed pumping, general water supply systems. Another important use is hydraulic stripping of over-burden on top of mine or quarry.

Texrope, Vari-Pitch, Magic-Grip, Ripl-Flo, Low-Head, Aero-Vibe, Tri-Slope, Sta-Klean, Thermo-Deck, Chlorextol, Electrifugal, Magic-Grip are Allis-Chalmers trademarks.

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The 1957 . . .

Coal Age Mining Guidebook

Deep Mining

Stripping

Preparation

Safety

What It Offers . . .

EXTENSIVELY REVISED and brought up to date with new methods and equipment developed in the past year, this 1957 edition of the Coal Age Mining Guidebook is 40% bigger than the 1956 edition. Three new sections have been added and major additions have been made to most of the others. The subjects of the new sections are:

1. Production standards and control
2. Continuous mining
3. Training of miners, managers and supervisors.

Designed for continuing reference in checking, developing and improving mining practices, and in purchasing equipment, materials and services, this third in a continuing series of Guidebooks provides these three services:

1. Practical, down-to-earth, up-to-date and continuously useful data on basic principles, modern practice, and modern equipment and materials for cutting costs, raising product quality and promoting safety in both deep and strip mining.

2. Special data on equipment, materials and services for modern mining. In this section, the manufacturers present key information on the products, materials and services they offer the coal-mining industry.

3. Where to buy equipment, materials and services. Arranged by products and including trade names, this buying directory is designed to facilitate the location and purchase of equipment, materials and services by conveniently arranged listings of who offers what and where they can be found.

Who It's For . . .

THE 1957 COAL AGE MINING GUIDEBOOK AND BUYING DIRECTORY is designed for all men—organization heads, operating officials, engineers and designers, and electrical, mechanical, preparation, maintenance and safety men—involved in coal production, preparation, safety and related activities, including the purchase and use of equipment, materials and services.

Face foremen interested in improving face haulage, as an example, will find a discussion of basic principles and modern practice under "Transportation" in the Deep-Mining Guidebook. Organization heads, operating officials and maintenance men, deep and strip, interested in improving their maintenance setup will find a separate Guidebook devoted to this subject. And the what, where and how of machine application—and the results that can be attained—run through the entire Mining Guidebook, with the Buying Directory and manufacturers' pages handy as a reference in purchases—not only of equipment but also of materials and services.

How to Use It . . .

CHECKING MINING PRINCIPLES AND PRACTICES—What the six main divisions of the Mining Guidebook are and where they appear is shown in the general index on p 3. For added convenience, detailed indexes on the material appearing in each division precede each such division and permit rapid locating of the material on specific topics, such as, pitch operation in deep mining, haulage in strip mining, dewatering and drying in preparation, and so on.

BUYING EQUIPMENT, SERVICES AND MATERIALS—For locating the makers of, for example, wire rope, vibrating screens and lubricants, check the appropriate product classifications in the Buying Directory, beginning on p 289, and consult the data provided by the manufacturers in the advertising section. EXTRA in 1956—a list of sales offices and representatives of advertisers in this issue by states. See the Advertising Index for the office nearest you.

Operation Standards, Production Control

Developing Systems ..... p 18
Forecasting ..... p 19
Staff Selection ..... p 21

THE INCREASING COMPLEXITY OF MINING introduces demands for control data which have been satisfied by various methods. In the early days, production quotas were the guesses of foremen and other experienced supervisors. This method yielded approximate answers because the men who knew the details of the operation were in direct contact not only with production but with all associated phases of the operation. As a result, the more experienced and better informed managers in those days were able to make reasonably sound decisions with a minimum of auxiliary staff departments supplying pertinent data. The determining measure of a man's worth in this period was established by the actual profit achieved by the operation. High realization, good working time, a favorable labor situation or good natural conditions were as effective as ability or effort in achieving production potentials.

Since all producers did not enjoy markets more favorable than their competitors, and certainly all mining operations did not benefit by prolonged encounters with favorable natural conditions, the more hard-pressed operators took steps to cut costs by installing cost-control systems.

As mechanization and specialization increased, detailed accounting and payroll methods were demanded for each operation. Actual costs were studied to provide workable average costs in various categories. Mechanization naturally resulted in a reduction in labor costs and an inflation in supply and maintenance costs. Therefore, first attempts to systematically control costs were directed toward the use of supplies, control of inventories and improved purchasing. Very often these economies actually reduced the production potential, but since there was no adequate method of determining this production potential, the loss was ignored or blamed on adverse conditions.

The largest unknown is the labor cost per unit. Also labor cost is the largest element of expense and the greatest variable. The principal reason for variation in labor cost is the lack of control and absence of measurement, and curtailment of overtime does not constitute a workable labor cost control by itself.

Except for the first stage of immediate supervisory cost control, the accumulation and computation of cost and production information has been removed from production personnel. The introduction of production standards and control—industrial engineering—has bridged the gap between practical mining and the measure of required work and potential costs. Also, with the introduction of industrial engineering methods the early evolution of seeking controls for costs had to be repeated. Control through industrial engineering is based upon measuring actual costs against potential costs, rather than measuring actual costs against past performance.

Developing System

Do not set up arbitrary standards based upon "adjustments" of data.

Full endorsement by management is necessary to make a standards system effective.

FIRST ATTEMPTS to initiate these methods were very little removed from the old-time guess of the immediate supervisor. Time study dealt with actual and over-all times, and "adjustments" based upon empirical factors were common. As was the case in the original "past-performance" type of measure, the next step in time-study development was to build rough standards based upon averages with or without the aid of performance rating.

It is obvious that the introduction of any variable or change in conditions will not have a like effect on all elements within a given production cycle. The factors which would alter the standard values on a man-paced or manual operation might have no effect on a machine-paced operation.

In mining, production is principally the product of a man-machine unit carrying varying work loads ranging from 100% man-paced to 95% machine-paced. Each operation contributing to the cycle is independent, but it is also establishing limitations on the subsequent operation in the cycle. Unless each phase of the manual operations can be studied independently from the machine-paced operations, the resulting production standards are merely an estimate or compromise with the variables cacsed by changes in natural conditions. Arbitrary blanket adjustments are basically incorrect when applied to a combination of man-paced and machine-paced elements of work.

Failures of industrial-engineering or elaborate cost-cutting programs have been recorded in the coal industry. It is generally agreed that these failures can be traced to either arbitrary standards or lack of endorsement by management. Understanding and endorsement by management help to insure practical

Case Finder—Production Control

Industrial Engineering—Time study and operation analysis, performance standards, cost budgets, supervisory bonus plan. *Coal Age*, January, 1957, p 80.

Control Standards—What the benefits of standards are; how to set up standards using an auger-mining operation as an example; how to use reports to control production after standards are set. *Coal Age*, March, 1957, p 70.

methods and create confidence in the foremen who must install the changes.

In most mines where workers are not producing a "fair day's work", time studies usually indicate that the basic trouble is waste effort and not lack of effort. The workers are doing unnecessary work because of poor methods or lack of positive supervision, or there are delays resulting from mechanical failures, or lack of planning and poor scheduling hamper their productivity.

Management usually is aware that sound programs for setting production standards and controls will point out management's errors as well as the errors of subordinates. This may be the reason why inefficient organizations show greater criticism of such programs than can possibly be explained by a natural resistance to change.

Forecasting

Detailed economic study eliminates the possibility of making capital expenditures on less-than-complete information.

Analyses of spending plans should be made by a qualified individual or staff.

ONE OF THE MORE TRYING TASKS of management is that of forecasting costs. In many instances large sums of money are allotted to the purchase of new equipment, opening new mines or installing new methods. Most often these expenditures are the direct responsibility of persons who have not been provided with the necessary training for properly approaching economic problems. Sometimes estimates are demanded of management personnel who have not the time to adequately investigate these capital expenditures, nor are they provided with an adequate staff or qualified individual to whom such analyses may be properly delegated.

A proper measure of all work and cost elements, provided by an effective industrial-engineering department, could eliminate the possibility of wasting money on "brainstorms". The industry is cognizant of the fact that any operation must make progress to remain competitive. Yet in many instances the installation of new methods or equipment is postponed or cancelled because management cannot measure the merits of the proposed change. There is either reluctance to "go out on a limb," or

Eleven Musts in Setting Good Standards

1. Standards should be simple and easily understood. A system that is mysterious, complicated or cumbersome is hard to apply, difficult to change should conditions change, and too time-consuming for a busy owner or manager to wade through each day. Rather, standard controls should be presented in such a way to the owner or manager that he can look at the daily figures, get a quick picture of what his equipment has done the day before, see how delays occurred, and ascertain the actual money loss of each delay. Then he can make his decisions for the day then and there.

2. Standards should be designed to tell an owner not that he lost a certain amount of money alone but how and exactly where he lost it so that he can do something quickly if he wishes to cut down or eliminate the loss.

3. To get the most out of a standards program, an owner or manager aiming at improving his operation should take an active interest in the program, understand its basic principles and be its most powerful salesman so that all others within the organization can see and hear, and thus more quickly accept and participate in standards for their own best interest and also for that of the company.

4. Application of standards should be thorough so that no backtracking is necessary later. A sloppy standard, set either too loose or too tight, gives the standard-setters and company a bad name.

5. In initiating standards, owners or management should not load the standards men with jobs not connected with their regular work. This is especially true while standards are being initiated, and becomes more understandable as the department grows in stature and experience.

6. Care should be taken that highly skilled standards men do not waste their time doing routine reports or work that others can and should do.

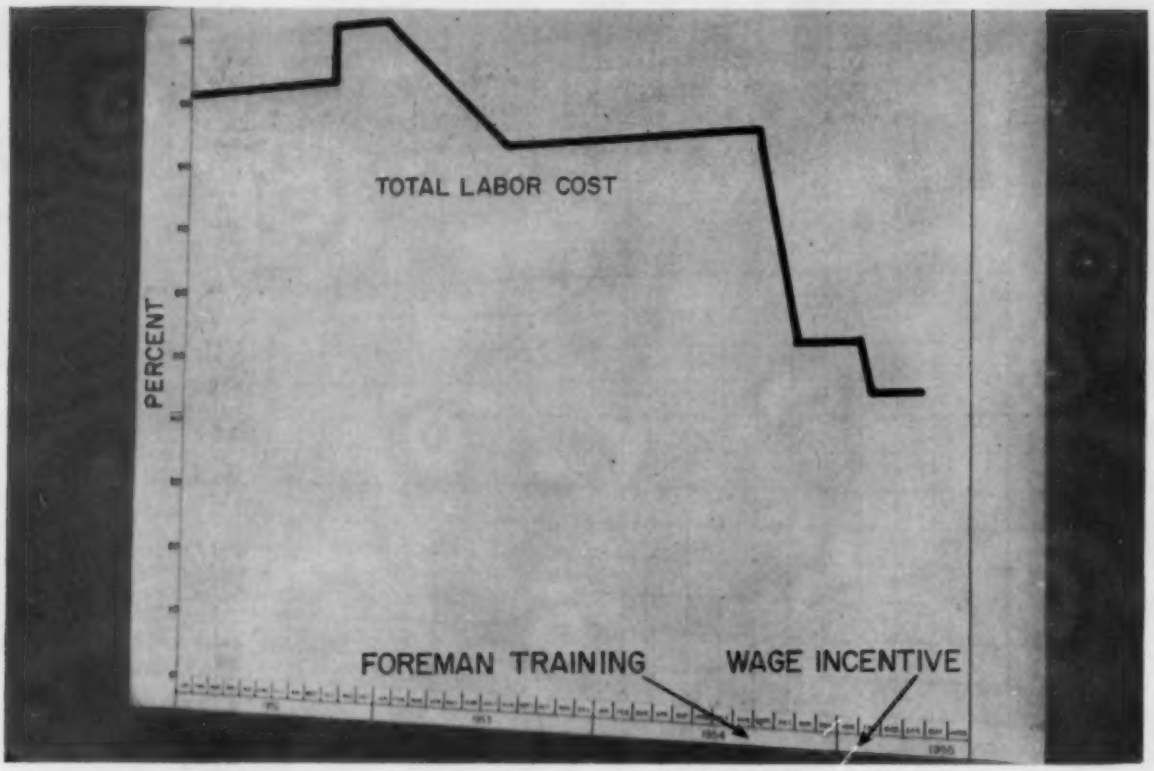
7. The owner or manager, when he has his forecasts of improvements before him and has compared with past performance should not let his enthusiasm be dampened by his past showings. If he can raise production with standards, his superiors cannot criticize past performance when standards were not available. Men should be praised for progress and criticized only for holding it back.

8. Production men should not feel that men in standards are trying to muscle into their sphere. Rather, standards men are, in a sense, only toolmakers. Production takes these tools and uses them, thus, it is hoped, doing the job better and, as a matter of fact, getting more satisfaction and credit for themselves.

9. Standards men should rarely give orders to workers. Giving orders is the job of production only.

10. Care must be taken by the owner or manager to keep production and standards a little apart and on an even plane so that the two can work side by side for the betterment of the company.

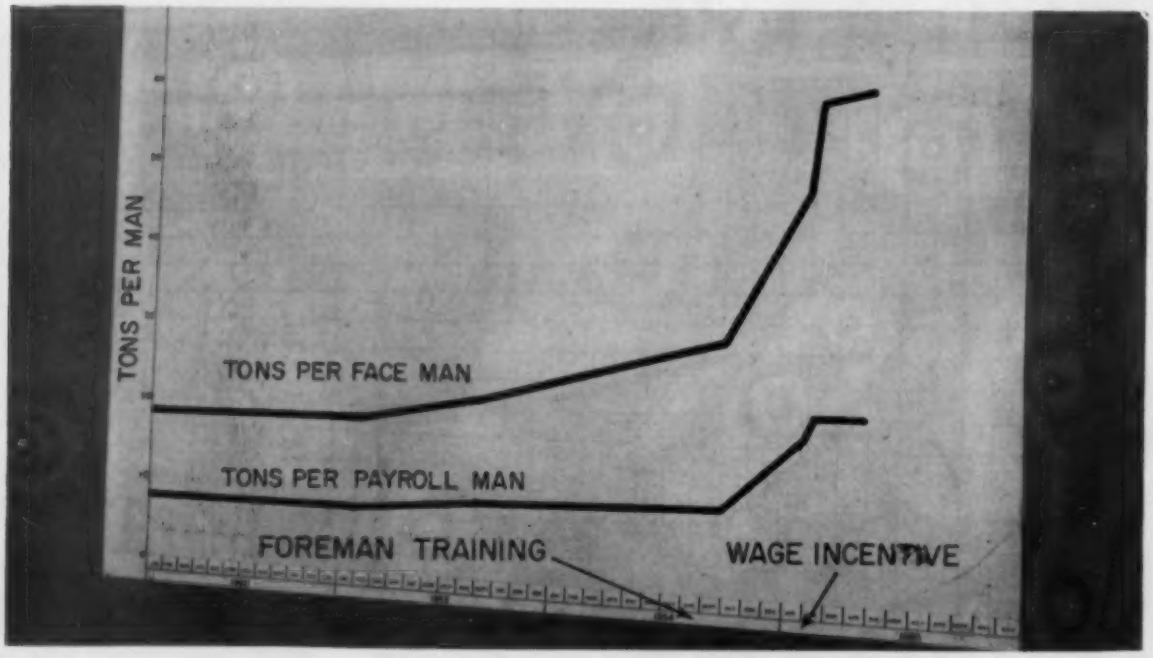
11. The owner or manager must not expect too much too soon. Standards can point the way to maximum results in production but attaining these results is a long hard process.



Labor costs down

SETTING STANDARDS of operation and designing production controls to achieve the standards lead to higher efficiency and noteworthy cost reductions. These are the benefits when management is advised by a competent standards-and-control staff.

Productivity up



estimates of savings in previous ventures have not come up to expectations. Therefore, further changes become difficult to sell. Industrial-engineering analyses can contribute to management's effectiveness in forecasting savings and costs.

Perhaps the major objection to industrial engineering is the lack of results that have been shown in certain isolated applications in coal mining. Successful applications have several common characteristics, and an analysis of these successful applications indicates the prerequisites for successful cost-reduction programs.

Staff Selection

Consider the advantages of training mining engineers for standards work.

Operation standards and production control are tools which, like any tools, must be used to be effective.

INDUSTRIAL ENGINEERS with no direct knowledge of coal mining have been employed to set up cost-reduction programs for coal companies. Other applications have been attempted by mining people with no exposure to modern, improved industrial-engineering principles and practices. The programs now in effect in the coal industry which are considered to be highly beneficial by the companies using them are a combination of practical coal mining and sound industrial engineering.

It is generally agreed that it is easier to train a mining man in industrial engineering than to train an industrial engineer from another industry in good mining practices. One consulting group, composed of mining engineers who specialize in the installation of production-standards programs for coal companies, lists the advantages and disadvantages in these two approaches to the problem of staffing the department, as follows:

When an industrial engineer is brought into the mining industry he is usually possessed of broader experience. However, he seems to have difficulty gaining acceptance, he enjoys a higher pay scale and he may move on after a relatively brief period of employment.

Men within the industry lack the industrial-engineering experience, except in a few companies where such programs have been long established. But men familiar with mining can develop rapidly once they are trained by competent consultants. The men within the organization provide a valuable source of future supervisors, and advancement within the organization strengthens morale while reducing turnover.

The greatest advantage of building a production-standards department around experienced mining engineers and mine foremen is that the new concepts and methods are presented to the operating personnel in understandable terms, and safety and mining laws are fully considered. Since the basic data are taken and compiled by members of the standards department and installed and maintained by operating officials, both groups must be able to work as an integrated team, each aware of the other's approach in solving problems.

The standards department operates best as a staff function or advisory group. It is important that the head of the department report to the chief of operations.

Industrial engineering is a tool designed to measure potential. Once the potential is properly established, it is the function of industrial engineering to determine the frequency and severity of deviations from the potential of the particular operation. The deviation may be expressed as wasted time or it may be converted into wasted dollars. Thus the urgency of eliminating or reducing the waste is evident to all. Like any other tool, the system must be used to be of any benefit to the organization.

REPORT OF
SECTION EXAMINATION AND CLASSIFICATION

MINE NO..... DATE..... I.E.REPR.....

SECTION LOCATION	SECTION FOREMAN	NO. OF MEN

PLACE	CLASSIFICATIONS		

AVERAGE CLASSIFICATION:

STD.TONS/SHIFT	STD.TONS/MAN	NO. CARS/SHIFT

COMMENTS

TRACK OR ROADWAY	SHOOTING
CUTTING	LOADING
DRILLING	CAR OR BUGGY CH'GE
DUSTING	TRIP CH'GE
POWER GOOD ☐ BAD ☐ INT. ☐	SUPPLIES

COMMENTS AND SUGGESTIONS

CONTROL REPORTS which take guesswork out of decisions are the foundation of scientific management. Actual vs. standard costs are quickly seen.

The Deep-Mining Guidebook . . .

NEWEST IN SLOPE SINKING—Rock loader teamed with extensible belt. In a 9x18-ft slope on an inclination of 15 deg, this unit was making it possible for a four-man crew to advance 4 to 10 ft per shift, including roof-bolting and rock-disposal.

NEWEST IN SHAFT MUCKING—1-yd tractor loader with electric motor loads into sinking bucket.

Portal Location	23	Shaft Sinking	27
Sinking Rock Slopes	25	Rock Tunneling	28
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Opening and Development

Portal Location

Locate, as a general rule, for lowest mining cost over life of property consistent with convenience for men and handling of coal and materials.

Consider the needs for raw- and prepared-coal storage.

Consider the possibilities of locating to facilitate present or future water connections, either directly by a plant on water or by truck, rail or overland belt from mine to barge-loading plant.

ON THE BASIS of an output of a million tons a year, developing and equipping only the mining part of a deep-mining operation represents an investment ranging up to $6 million, depending upon the amount of grading, shaft and slope work, and rock and tunnel work necessary, along with other things. About the minimum today is $2 million. Investments on such a scale as this require more than ordinary care in all respects, including location of the portal or portals. If a poor location, for example, increased the average cost only 5c a ton, the total loss in 20 yr would be a flat million dollars.

A number of diverse factors must be studied and balanced, one against the other, in arriving at the lowest-cost location of the main opening and the main plant. Normally, if only a shaft or slope is required and the coal is level or only slightly pitching, the shaft or slope is placed as nearly in the center as possible. This keeps haulage and travel distances to the minimum over the life of the property. Normally, also, other things being equal, the opening should be made to permit hauling loads on the level or downgrade as far as possible if the dip of the coal is over, say, 1½ or 2%.

Other factors having possible weight in portal location include:

1. Space for parking as many cars as may be necessary, preferably on level or nearly level ground for easy movement when snow is encountered.

2. Space for coal storage either at the time the plant is built or at some later date. Storage facilities for as much as a week's run or more of raw or prepared coal, or both, are not uncommon nowadays, and even where capacities are more modest the trend is toward providing bin or ground space for a half to a full day's tonnage.

3. Space for expansion of the plant if desired at some

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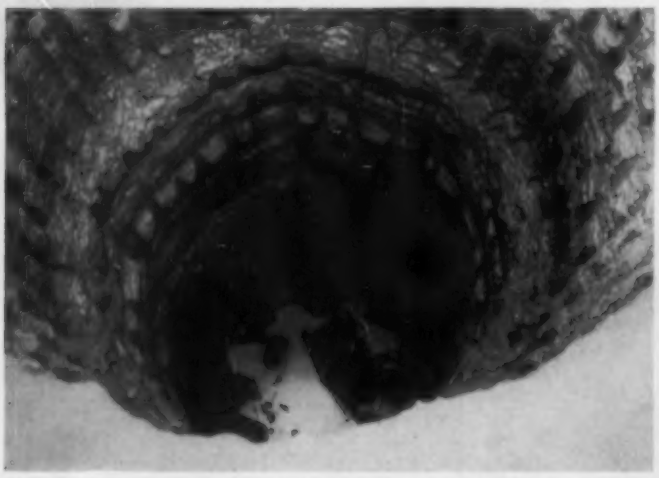
HELLDIVER (left) facilitates loading in sinking coal slopes. The big drill (right) is one tool for speeding up the raising of parallel airways, drilling as many openings side by side as are required for the necessary air flow.



DRILLING FIRST to outline shaft where cover is thin speeds sinking and protects walls against shooting.

BIG CORING-TYPE DRILL sinks auxiliary air, man and materials shafts quickly and economically.

DOUBLE-ARMED TRACKMOUNTED JUMBO speeds drilling and reduces cost of tunneling or heavy brushing.

LOWER COST is among advantages of exploiting outcrop. Here, shovel and bulldozer develop for auger mining.

future date, or for the addition of some type of equipment that might come into use at some future date.

4. Availability of water for plant use if washing is done or contemplated.

5. Space for sludge ponds and clarification equipment if such equipment is installed when the plant is built. If not installed at that time, it should be contemplated that it might become necessary at some future date.

All of the preceding factors might dictate a longer haul or a deeper shaft or slope to permit a more economical plant location from all standpoints, including excavation, grading and foundations. And since a surface haul normally is cheaper than underground, the availability of such a haul might in itself warrant a change from dead property center for the portal. Where an area is to be worked from several portals a surface haul or hauls to a central preparation point is the natural thing.

Putting the portal and the preparation plant at separate places may be the better answer to the dual problems of putting the opening at the best point for low mining costs, and the plant at a point where space is available for good design, ample coal storage, ample water supply and so on. This fact is reflected in the growing number of operations where this plan has been or is being adopted. The connection between the portal and the plant may be an extension of the mine-haulage system, particularly if it is of the rail type, though overland belts have been installed for the same purpose; a truck route; or a standard-gage rail route, depending upon conditions and cost studies.

Location of the preparation plant completely away from the mine is a further possibility. In fact, it could be located in a consuming area or at some convenient way point where water, space and other necessities were plentiful, along with a wider choice of transportation facilities; for example, a combination of water and rail.

However, moving the preparation plant away still leaves the problem of shops, parking areas and other facilities. A major question is the opening or openings for men and supplies. Unless the terrain makes it impossible or prohibitive in cost, the need for keeping travel time to a minimum has led to widespread sinking of auxiliary slopes or the opening of auxiliary portals at intervals as the mine develops to keep down underground distances for men and supplies.

If a possibility exists that water transportation to market might become available, the reduced freight rates which it makes possible, and the competitive advantage to be gained from such reduction, warrant a careful study to make sure that either the mine portal or the preparation plant or both are located so that the mine can avail itself of the opportunity. One factor, if the mine is away from the river, is the most economical haul in relation to any increase in mine cost might be incurred. Another is a suitable site on the water for the location of the barge-loading facilities. Of course, if the coal acreage is on a navigable stream or waterway leading to a major market, the natural step is to include facilities for loading to water.

Sinking Rock Slopes

Muck with loading machines and transport on conveyors in slopes designed for belt hoisting.

Consider the possibilities of continuous miners to eliminate drilling and blasting where there is not a great deal of very hard material, such as, sandstone and limestone.

Trend Markers—Opening and Development

Slopes firmly in favor as the main opening or openings for mines where hoisting must be done.

Loaders and conveyors the major tools for sinking belt and other moderate-pitch slopes. Rock loaders and extensible belts are new contenders promising a substantial increase in sinking speed.

Drilling to outline shallow shafts and decrease shooting burden and shock to walls a growing practice, along with mucking with clamshells.

Overshot loaders and tractor shovels operated by air or electric motors coming to the front for mucking in large-sized shafts.

Drilling of auxiliary shafts for ventilation and handling men and supplies a growing practice.

Retreat systems, either full or modified (advance on one side and retreat on the other; retreat within panels, as examples), now practically universal in new layouts.

Wider use of bridge conveyors and continuous miners resulting in a trend to a smaller number of headings in development work.

Case-Finders—Opening and Development

Mechanical Shaft Mucking—Overshot loader used in 37x14-ft air shaft. With 11-man crew sinking rate is 6 ft per shift. *Coal Age*, July, 1956, p 72.

Slope Sinking With Rock Loader and Extensible Belt—How this combination of equipment is used to attain rates of 4 to 10 ft per shift in 9x18-ft opening with four-man crew. *Coal Age*, November, 1956, p 68.

FOR SINKING SLOPES IN ROCK, where the mining company prefers to do the work itself, the following equipment, in addition to the loading, drilling and other production units, normally will be required:

Shovel, dragline or bulldozer for preliminary excavation if the material is fairly deep and soft. A bulldozer normally is required in any event for miscellaneous earth moving and excavation, and for spreading refuse. These and certain other units frequently can be rented, rather than purchased.

Storage bin on surface unless muck is dumped directly to trucks. Normally, a bin will pay off by preventing delays and interruptions.

Refuse-disposal and service trucks.

Electrical substation or engine-generator plant.

Field shop.

Field supply house.

Field office, locker and change facilities. These, as well as the field shop and supply house, may all be in the same structure or separate buildings may be employed, including semiportable or prefabricated. Though it is not usual practice, the permanent buildings to serve the mine throughout its life may be erected in advance of portal development.

Fan or tubing blower, with duct or tubing.

Water supply for wet drilling, sprinkling and general use.

Pumping equipment, if necessary, for dewatering slope.

Concrete-mixing facilities, unless ready-mix is available at a desirable price. As an alternate to at least part of the concrete work, steel liner plate may be employed. Concreting or lining normally is done only for the softer section of material at the top of the slope. Below that, the natural-rock ribs normally will stand and the top can be taken care of by bolting or conventional timbering. Bolting also may be employed to keep ribs from sloughing or caving. Spraying with a sand-cement mixture on wire mesh also may be done to prevent spalling and disintegration as a result of temperature and moisture changes, or the ribs may be coated with roof-sealing compounds.

The usual belt slope also is employed for handling men and supplies. Consequently, the belt normally is placed to one side with the track at the other and the stairs in the center. However, all other arrangements have been employed, including increasing the height of the slope and putting the belt on crossbeams over the top of the supply track and stairs. In one instance, this double-checking was done to cut slope width in poor ground.

The belt or supply track may be separated from the other facilities in the slope by guard rails, low concrete curbs or walls, or a center line of roof supports. For easy walking, one mine built experimental steps and had men try them. As a result, the stairs were built with a 6-in rise and a 24-in tread.

Because of the length of time required in sinking the longer slopes, and also because of the long tubing runs that would be required, it may become desirable to erect a center partition, thus establishing two compartments for ventilation. Rather than use shiplap or standard brattice lumber, thin-section plywood in standard-sized sheets offers economies in both purchase cost and cost of installation.

Methods of handling heavy inflows of water from soft water-bearing measures including standard grouting and also the use of gel-type chemicals which solidify after pressure injection and render the material impervious.

Sinking Systems

Depending upon the mucking system adopted, equipment normally employed in slope sinking is as follows:

HAND MUCKING

Hoist on surface (50 to 75 hp, single drum, in most instances; same hoist may be continued in service to handle supply cars in regular operation).

Muck car.

Air compressor.

Drilling equipment. In at least one instance, a slope has been sunk using standard post-mounted electric coal augers—reportedly at a substantial saving. Normally, however, air is required in going through rock. Hand-held or other unmounted drills may be used, but their footage is lower. At the other extreme, a track-mounted jumbo—one or two drill mounts—may be employed for maximum drilling speed in slopes up to 45 to 50 deg. even though it may be necessary to pull it out between rounds or provide special parking facilities near the face. Between the two extremes are column- or bar-mounted drifters or sinkers, as well as the newer air-leg or jack-leg units.

Roof-bolting equipment rounds out the list, unless conventional supports are employed.

Minimum crew for such a sinking job probably would be approximately as follows, these men also taking care of installation of lining and roof support when not engaged in regular duties: drilling shift—two or three drillers, mechanic or electrician, and a handyman (hoisting, supplies, etc.); mucking shift—two or three muckers, hoistman, truck driver and dozer operator. It sometimes is possible for one man to take care of all hoisting and refuse disposal, although normally more than one are necessary, in which event the truck driver, dozer operator and any others employed normally will handle miscellaneous duties. And, as noted, all men will be available for installing lining, supports and the like. On this basis, average advance in a 7x15-ft slope would be 3 to 4 ft per shift—perhaps more with favorable conditions or jumbo or other high-speed drilling.

MACHINE MUCKING

Where muck is loaded mechanically, the equipment setup may be as follows:

Hoist.

Muck car or conveyor system. The latter may be chain equipment only, or a chain unit may be used between a belt unit, which eventually will become the slope conveyor, and the face. The latest addition to the group is the extensible belt. Its use is outlined later in this section.

Standard coal-loading machine, or rock loader of the standard, overshot or slusher type.

Air compressor.

Drilling equipment—substantially the same as with hand mucking. However, where crawler loaders are used and consequently cannot be hoisted out readily it may be difficult to use jumbos because of interference.

Roof-bolting equipment (unless conventional support is employed).

Pitch usually dictates to a considerable extent the type of loader that may be employed. Standard or conventional loading machines usually are limited to 20 deg or less, though the overshot unit of the track-mounted type can operate on somewhat heavier inclines. With certain types of slushers, mucking can be done at up to 50 deg, other conditions being favorable.

The "helldiver," though employed mostly in coal (see following section on "Sinking Coal Slopes"), also may be adapted to sinking in rock at pitches up to 50 to 60 deg. Incidentally, where conveyors are employed to move muck the practical limits are about as follows: belt 17 to 20 deg; standard chain 30 to 35 deg; special high-flight chain conveyor designed for hoisting work, 45 to 50 deg. Where the slope is long, chains must be used in tandem, since the practical working length usually is not over 300 ft, particularly if operated up hill.

With slightly different duties, crews for machine mucking can be about the same in number as with hand mucking. Rate of sinking in a 7x15-ft slope, including lining and support, usually ranges from 5 to 10 ft per shift.

Mucking With Extensible Belt—Latest addition to the list of slope-sinking tools is the extensible belt. In combination with a rock loader at one new property (*Coal Age*, November, 1956, p 68), its use has resulted in sinking rates of 4 to 10 ft per shift in a 9x18-ft opening

(before lining) on an inclination of 15 deg. The 36-in extensible unit is equipped with a special 100-ft takeup to permit tramming a safe distance back from the face before shooting. It discharges to a truck-loading bin on the surface.

The sequence of operations includes drilling with telescopic leg stopers, concentrating first on bolt holes for roof support and then chancing to the face. Next the holes are loaded and shot. Bolting, face drilling, loading, moving equipment back, etc., including shooting, takes the four-man crew about 2½ hr. Loading is the next operation, with one man operating the loader, a second running the self-propelled tail piece of the extensible conveyor, a third acting as handyman at the face and the fourth working on the surface trucking away the rock.

Finished dimensions of the slope are 7x16 ft, achieved with a 1-ft concrete lining in part and a sand-cement coating on wire mesh on the remainder. The initial opening on the surface was made with a shovel and bulldozer, followed by installation of the concrete lining down to the solid.

CONTINUOUS SINKING

In addition to growing effectiveness in coal, continuous miners also are proving quite effective in slope sinking and other rock work where conditions are not too difficult. Equipment usually employed is as follows:

Sinking machine. To date, these have been of the boring type and have been used only in sinking belt slopes on inclinations of around 20 deg or less.

Conveyor System (muck car an alternate).

Roof-bolting equipment (unless conventional support is employed).

The use of continuous-type mining-and-loading machines for slope sinking is a relatively new development. Results so far indicate that advances of 10 to 30 ft per shift are possible, depending upon the hardness of the rock. Since hard sandstone, limestone and the like still are tough for mining-and-loading machines, they normally should be considered only where shales and other soft material predominate.

Sinking Coal Slopes

Use loading machines or continuous miners where pitch permits; where pitches are beyond those on which loaders or miners can operate, consider special units, such as, the "helldiver."

Where pitch permits, use conveyors for transportation. Special high-flight chain conveyors can operate at up to 45 to 50 deg.

EXCEPT THAT THE PRODUCT normally is not dumped to refuse, sinking slopes in coal is substantially similar in practice to sinking in rock. Equipment normally is of the coal type, and aside from loaders and the like, may include coal cutters unless pitch, interference or other conditions prevent their use. Except for certain anthracite applications and some exceptions in bituminous mines, electric coal augers are standard for drilling, and the cycle corresponds with the cycle in a room face.

Cars or skips may be loaded by hand up to 75 to 80 deg. Conveyors may be loaded by hand up the limit of 45 to 50 deg for the special high-flight hoisting type. With loading machines, the usual limit for conveyors is around 20 deg. The maximum nose-down pitch for continuous miners still is to be determined, but they are promising candidates up to 15 to 20 deg, as are continuous miners.

The "helldiver" is one of the special machines for fast loading in slopes up to 50 deg. It consists of a scoop on the front end of a weighted truck (for construction details, see *Coal Age*, May, 1951, p 100). With the scoop down, the helldiver is dropped into the loose coal at the face. In the hoisting phase of the cycle, the scoop is raised automatically and the entire unit is pulled to the dumping point—normally a hopper under the track with an opening between the rails. The hopper is above the haulage level and false rails permit hoisting over the level track. Coal is transferred from the hopper to cars on the level road by an elevating conveyor.

In 4½-ft coal, places 10 ft wide, with crews of 3 to 4 men, average production with the helldiver is one 7-ft-deep cut per shift, including installation of permanent roof supports and other necessary operations. With loading machines in slopes under 17 or 18 deg, 5-ft coal or thicker, the usual advance is 1 to 3 cuts per shift, with the higher figures possible as a rule only where there is little need for installing permanent supports. Advance with hand loading, whether into cars or conveyors, seldom is over one cut per shift with a 3- or 4-man crew.

Raising Slopes and Airways

Consider continuous miners for moderate pitches, and conveyor transportation up to sheet-iron pitch.

Consider big drills for parallel airways in steeper pitches.

MACHINE LOADING is as desirable in raising slopes and airways in either coal or rock up to say, 20 deg, as in sinking or production on the level. Although equipment can be installed to take cars to the face, the preferable transportation medium is the conveyor up the point where the material will run on sheet iron, which is around 30 deg. At around 35 to 40 deg, coal will begin to run on the bottom rock, and above approximately 45 deg, checks or batteries are required.

Where raising is done in coal, continuous miners have been successfully used in pitches up to 15 deg or better. In one instance, using pickup loaders, shuttle cars and cross-measure shakers for gathering, six airways were driven 1,500 ft up pitch to the outcrop by ripper-type continuous units with a substantial saving in cost over other methods. Maximum pitch encountered was 12½ deg.

In addition to raising parallel airways with conventional equipment operated from crosscuts off the main slope big drills also have been used. At one mine (*Coal Age*, May, 1951, p 100) such a drilling unit is fitted with a 42-in head, and one, two or three holes are drilled up the pitch to achieve the desired airway area. Drilling is done from crosscuts at the necessary intervals.

Shaft Sinking

Mechanize with tractor loaders for handling muck in large shafts or use special mucking machines mounted on the shaft wall or on the bottom of the cage. Consider the clamshell for mucking and hoisting in shallow shafts.

Drill to outline shallow shafts, reduce shock in shooting and facilitate mucking.

Drill outlying air shafts, supply shafts and even man and escape shafts.

SINKING METHODS may be influenced to a considerable degree by the type of shaft. Unless shafts are required rather frequently better results usually can be achieved by contracting their sinking, especially if they are large and deep, rather than by purchasing equipment and creating a staff of specialists. Surface facilities and sinking equipment, except for mucking, are substantially the same as in slope sinking (see pp 25-27). Lining materials, where required, include sprayed sand-cement and corrugated liner plates for circular openings, in addition to the standard timber, brick or concrete lining.

Muck may be loaded into a standard sinking bucket by hand, though in a multicompartment shaft where a heavy cage can be used in one compartment, new positive-action mucking machines mounted on the cage bottom may be employed in loading the buckets (see May 1955, *Engineering and Mining Journal*, p 82, for example). Machines operating from tracks on the wall of the shaft also have been used to good effect in the metallic and nonmetallic mining industries.

Where the depth is not too great, mucking may be done by a standard crawler-mounted clamshell operating from the surface. And if access to the bottom of the shaft is possible through openings that already exist or can be driven, the muck can be dropped through a pilot drill hole into mine cars below.

Where shaft size is sufficient to accommodate them, overshot loaders or loaders of the tractor type commonly employed on the surface speed up the process of getting the shot rock into the sinking buckets for hoisting. An accompanying illustration shows a tractor loader, with the diesel engine replaced by an electric motor, operating in a 15x38-ft shaft. Capacity of the unit is 1 cu yd. The rock is shot in 8-ft-deep rounds and then the loader is lowered into the shaft for mucking operation. Eventual depth of the shaft is 430 ft, and the concrete lining is poured as each round is loaded.

A new technique in sinking relatively shallow shafts—under 150 to 200 ft—which may also find application in even deeper openings, is outlining the shaft by drill holes on centers of 18 in or so, using either a strip-type overburden drill or a standard borehole machine (*Coal Age*, April, 1955, p 74). The same drill puts down inner holes as required for shooting. Mucking is done by a crawler-mounted clamshell. In addition to a high rate of sinking (9¼ ft per 7¼-hr shift with one 16-ft diameter shaft), the walls are protected from shock, need not be scaled in sinking, and stand well without lining after the shaft is completed. Mucking is done without men in the shaft, except for cleanup.

Drilling is finding increasing application as a means of sinking shafts for air and emergency purposes, as well as for men and materials. These drills operate on the coring principle, with the latest employing dry oil-well-type cutters on the drilling edges. With this latter machine, the entire drilling unit is lowered into the hole, along with the operator, and is hoisted to permit removing core sections. Its initial assignment (*Coal Age*, January, 1955, p 80) was drilling a 75-in hole 467 ft for a manshaft. The hoisting equipment for this shaft, incidentally, is of the so-called friction type without a rope drum or drums.

The cost of one recent drilled shaft for ventilation at another property was $127 per foot, including $13.62 per foot for building the road to the site, grouting and other work in preparation for the main drilling job. Depth of the hole is 976 ft and the time required for the entire job, including preparation, was 6½ mo, during much of which the weather was unfavorable. Diamond-drill holes were first put down to permit pressure grouting of the strata, and surface water was sealed off by drilling a 60-in hole 40 ft deep and concreting in a 54-in casing. This opened the way for drilling of the final 48-in hole.

Rock Tunneling

Drill with modern airleg or jumbo equipment for speed and reduced labor in preparation.

Load with slushers or rock loaders.

IN STARTING a rock tunnel from the outside, it may be possible, as in slope sinking, to use a dragline or some other type of excavator to go through the soft material. At some mines, this initial cut has been left open, with the sides stabilized by planting special ground covers. Spraying with a standard sand-cement mixture also has been successfully done to stabilize cut slopes. At others, a concrete section has been installed, as in slopes, and covered with excavated material. Cut-and-cover has the advantage that the material need not be hauled away, compensating in part for the cost of the lining.

Even though not designed for such duty, coal equipment often is pressed into service where rock tunneling is a special job occurring only once in a great while. The coal equipment, of course, includes loading machines and shuttle cars and conveyors. Where much rock tunneling is required, however, special rock facilities normally are employed. Rock machines include loaders similar to coal machines but designed for rock loading; also overshot-type loaders and slushers or scrapers of the 2- or 3-drum type, the latter providing a greater degree of flexibility in covering the entire face. The machines may load into rail cars, regular or rock-type shuttle cars or conveyors. Big (15-ton or better) shuttle cars and rock loaders are a popular combination in metal and nonmetallic mining.

Drilling normally requires pneumatic equipment and compressors. Drills vary from hand-held through airleg, post-mounted and bar-mounted types to mobile single-arm and double-arm jumbos. Where considerable tunneling is done and other conditions do not militate against them, the mounted jumbo normally provides the greatest capacity and the lowest cost in drilling.

In one 8 x 12-ft tunnel using a duckbill for loading, a crew for one shift was made up of a boss, three heading men and one loading-end man. Average performance was two rounds 6 ft deep every three shifts. Drilling time (two drifters on a bar) averaged 3½ hr per round, and loading time, 6½ hr, including temporary timbering, advancing conveyor, etc.

In one 14 x 8-ft tunnel driven with a regular rock-loading machine, average performance was two 10-ft cuts per day of four 6-hr shifts. A four-man drilling and charging crew using two post-mounted drifters normally drilled and charged 26 holes in less than a shift. The cut then was completely mucked on the next shift by a 3-man crew. A ditch 5 ft at the top, 3 ft at the bottom and 3 ft deep was mucked by a hoe-type scraper working behind the rock loader.

In an 8 x 12-ft tunnel with 2 x 1-ft ditch on one side, drilling was done by a trackmounted double-arm jumbo and a car transfer was installed to facilitate switching cars behind the rock loader. The jumbo crew consisted of four men and the loading crew of 3 men. Average advance was 1 ft per hour. At this operation two or more places permitted shifting the machines back and forth.

Mine Projection

Plan for retreat operation, either full retreat from the inside of the mine out or at least in sections or panels.

FULL-RETREAT MINING, meaning mining from the boundary back to the bottom or portal, is the ideal system, with exceptions so few as to be negligible. Before the advent of the mining-and-loading machine, or continuous miner, however, the rate of entry advance was relatively slow, even with the best of machines and systems. Therefore, complete adherence to the principle meant a rather lengthy development period during which coal production was relatively small. As a result, a number of compromises were employed to get coal out during the entry-driving period.

One compromise providing results frequently as good as full retreat is advance on one side of the mine or working territory and retreat on the other to complete extraction. The basic principle is followed completely if full retreat is practiced in the individual working sections, though here again rooms may be mined on one side of a production entry on the advance, and on the other side on the retreat.

Other methods of providing coal while entries are being driven for a full or approximately full retreat system include setting off a special territory well protected by barriers near the bottom or portal, which can be mined, caved and abandoned without risk of affecting the permanent facilities. And where the coal outcrops along a hillside, quick production can be attained by moving in a shovel and stripping the outcrop, not only recovering coal in the stripping operation but also opening up the vein for augering or for deeper recovery by standard underground equipment, such as, a panel belt with loaders or continuous miners, shuttle cars and auxiliaries. If heavy rock or some other handicap makes true stripping undesirable, but conditions are such that benching is feasible and economical, augering or paneling still may be not only a help in development but also a source of considerable low-cost tonnage while the mine is getting started.

With the development of the mining-and-loading machine, the problem of going to full or near-full retreat in the thicker seams—and eventually in the thinner—is materially simplified. This results from the fact that the machine's rate of production is the same or almost the same as when working in rooms. Therefore, if the plan is to use four machines two shifts, they can all be concentrated in driving headings, providing full or nearly full production from the time of breaking away from the bottom or portal.

Contour Development

In mining hilltops and knobs, the panel belt and other modern equipment permits economical recovery at a high rate of production, whereas such areas frequently were impossible to operate when everything had to be done underground. Now, the outcrop is opened by a bulldozer or shovel—the latter normally is required to make the necessary width of bench—and the coal is mined by all-conveyor units of the hand-loaded or self-loading types; by loading machines and shuttle cars feeding to mother conveyors or panel belts; by continuous miners and extensible belts, and so on. The belts in turn may feed to mine cars on track laid on the bench. As an alternative, especially where it is desired to work sections large enough to warrant a mainline belt, the coal may be discharged to a semiportable storage bin for trucking to the main plant. By erecting the bins in multiple, it is possible to store the full output of a second shift, for example, eliminating the need for trucks and preparation facilities on that shift.

In addition to conventional equipment, contour development and production may become one of the special provinces of the remotely controlled mining-and-loading machine. Remotely controlled boring-type equipment has been or is operating at distances up to 1,000 ft from the outcrop with both articulated conveyors and the extensible belt.

Section Setups

One question in setting up a mining section is whether to aim for complete isolation: in other words, a panel completely enclosed by pillars with no openings except for the panel headings. Considerations favoring complete closing of panels include: liability of the coal to spontaneous combustion, and the possibility of breaks in the roof to water-bearing strata. Closed panels facilitate sealing and damming where fires or water breaks occur. The closed panel also facilitates sealing to comply with legislation or the rulings of inspection departments.

Pillaring within a closed panel, however, is more difficult unless conditions are more favorable than those usually encountered. Therefore pillars frequently are left in place where panels are closed, though a number of operations recover them quite successfully.

Among the benefits of the panel system, whether completely closed or open, is ease in establishing splits for each individual working section. The panel system also lends itself somewhat better to the establishment of bleeder headings—a growing practice where gas emission is heavy and even where it is not for a general improvement in conditions. A major advantage is the fact that the working places are always in fresh air since the travel is one way over the active workings and gob areas to bleeder openings. An added benefit of such openings is the fact that they provide additional escape routes in case of disaster.

Bleeder openings may be established in a number of ways. Examples are:

1. In room work on the advance, driving a place fron. the face of the first room, when it reaches full depth, back to the return of the main or cross entry from which the room entry was turned.

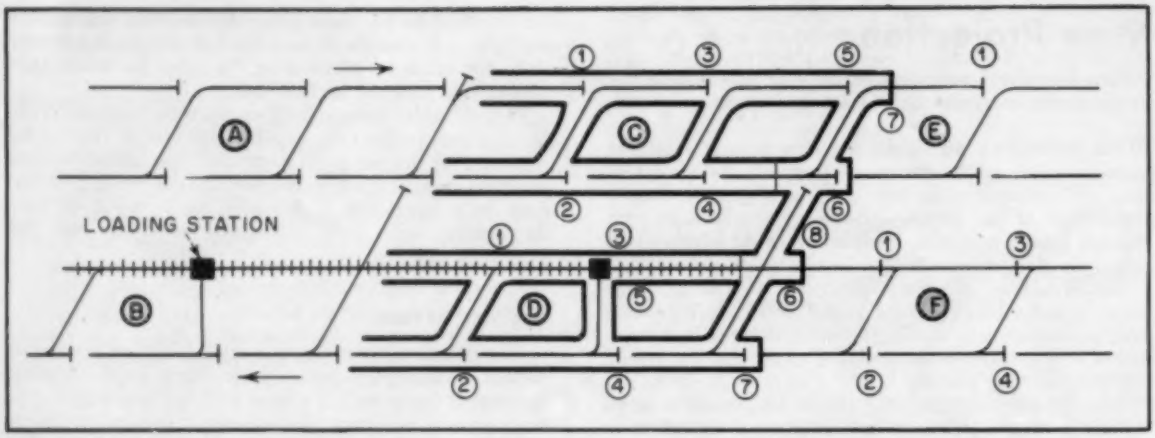
2. Driving a special bleeder entry and escapeway at the tops of room panels, or between panels turned toward each other, and cutting into it by extending the room entries, or by driving over to the bleeder from the faces of the first room or rooms to be completed.

3. Extending thhe first rooms to be completed to cut into a bleeder opening made by leaving the pillars in at the faces of the rooms in the preceding panel. As each room is cut into the old panel, the old pillar is included in the extraction routine to complete recovery.

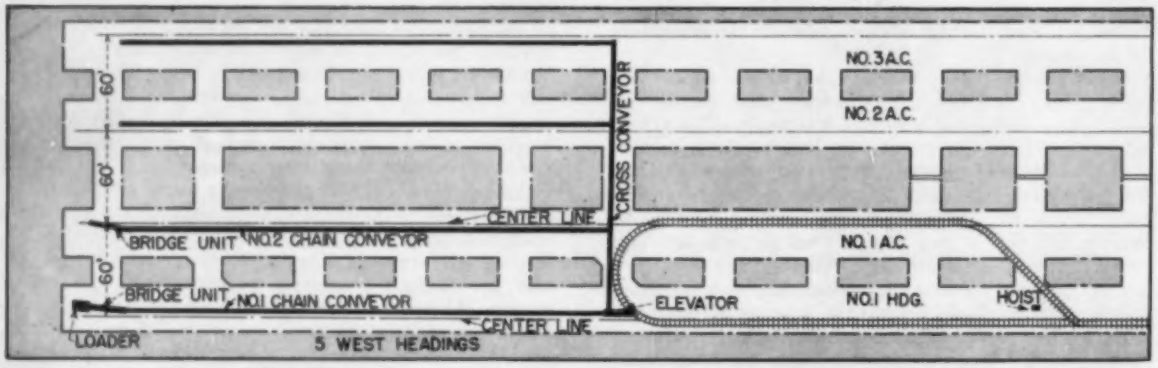
These and other methods of establishing bleeders are illustrated in plans in the "Continuous Mining" and "Conveyor and Machine Loading" sections of the Guidebook.

Pillaring Practice

A second question in setting up a mining plan is whether to take pillars or leave them. Where the coal is thin, adding to the difficulty of mining, and the top is good enough so that pillar size may be cut down to a minimum, the tendency is to leave pillars. In contrast, pillars also are left in some thick-coal areas because of bad top. Basically, however, taking pillars, unless some



FOUR-HEADING MAIN ENTRY for development with boring-type continuous miner. Alternating from left to right the sequence of advance is shown by the letters and numbers. One objective is to keep shuttle-car tramming distance down and thus increase miner output.



BRIDGE CONVEYOR-LOADER SETUP with loop track for cars is one of the entry-driving systems providing maximum advance with minimum cost. Cross conveyor brings coal from all four places to car-loading elevator.

special conditions prevent, is desirable to get full return on the necessary expenditures for entry-driving and other development operations. Leaving a third of the coal, for example, means driving, supporting, equipping and maintaining a third more room entries for a given tonnage.

A subsidiary question is pillar size and shape. As a general rule, these are set by experience with the top, bottom and other natural conditions in the region, with another factor whether or not recovery is immediate. Aside from the weight question, square blocks and a standard width of opening everywhere result in uniform pillaring conditions all the time, thus tending to raise efficiency. Angle driving, yielding "diamond" pillars, substitutes, as a rule, 60-deg turns for 90. Both mine cars and shuttle cars are favored by these gentler turns, but ease of operation in other directions may dictate retention of the 90-deg principle.

Changes in equipment type also influence practice in sizing pillars. Thin pillars between rooms, for example, facilitate crosscutting and pillar extraction with bridge conveyors. Otherwise, after the reach of the bridge unit is exhausted, an auxiliary cross conveyor and drive would be necessary. Even without special equipment, thin pillars may be desirable for several reasons. To get maximum extraction in first mining, as an example, one operator reduces pillars to two-cut thickness. The final recovery step is slabbing one cut off the pillar and leaving the remainder.

Entry Driving

After providing sufficient airway area, adjust openings to needs for other services and to type of equipment employed in development. With loaders and shuttle cars, for example, more than less is the general rule. With bridge and room conveyors, fewer is the usual rule; likewise with continuous miners regardless of the type of transportation employed.

Load rock mechanically and stow in mine if possible—as close to the loading point as practicable.

NUMBER OF OPENINGS becomes possibly the first question in developing an entry-driving program. In moderate to steeply pitching coal, the difficulties of developing under such conditions normally limit the number to two—a gangway for haulage and an airway above. At a fair number of collieries, gangways in coal have been given up for rock tunnels underneath the vein, though the airway still is made in the coal as a rule, with connections for ventilation and mining through rock chutes. In lighter-pitch coal, conditions are more favorable to increasing the number of openings, though the general practice still is to keep the number as close to two as possible.

The possibilities of both development and room work with continuous miners in coal under approximately 15 deg have been definitely proved in past few years. In

one instance, where the inclination is 12 to 15 deg (*Coal Age*, August, 1956, p 60), ripper-type machines driving gangways and counters across the pitch discharge to shaker conveyors. Rooms are necked from the lower gangway but with the exception of every third one, driven for ventilation, are not cut through until they are needed on retreat out of the panel. The coal is transferred from the shaker on the lower side of the gangway to cars on track laid in the center after the bottom is lifted for the requisite mining height. The mining plan used at this particular operation is included in the section on continuous mining in this 1957 Mining Guidebook.

Among the factors involved in establishing the number of headings for an entry in flat-coal mining is airway area. In the thinner seams, especially if the air volume is expected to be large, driving additional openings to keep down velocity yields substantial savings throughout the life of the mine. But even after all the necessary openings for haulage, ventilation and man travel have been provided, it still may be desirable to increase the number. This is especially true with loading machines, and to a lesser extent with certain other equipment. The goal in increasing the number of headings is to make development work as near like room work as possible, which means the lowest cost, aside from a higher tonnage from the equipment involved. And since this makes development and room work nearly alike, management is relieved of a large part of the complications involved in scheduling development to provide production territories.

The continuous miner and the bridge conveyor, among other new devices, are, however, reducing the need for increasing number of headings for the sake of lowest face cost. A loader in two places equipped with bridge conveyors, for example, often can achieve higher tons per machine and per man, and thus a lower cost, than the same machine with conventional transportation in a considerably larger number of places. This is particularly true in the thinner seams. Therefore, if only four headings were required for mine development, keeping to that number would not curtail unit output or militate against low cost.

With continuous miners, the case is even more pointed. Such a machine, in effect, doesn't care whether the opening is a heading or a room. Therefore, it is not oversimplifying things to say that the production and the cost are the same. Consequently, there usually is no need to increase number of headings to enable the machine to do better, though the number may be increased for other reasons.

Equipment for entry driving in coal normally is the same in type and general method of use as in other coal work. With mine cars or shuttle cars, any convenient layout for track or transfer stations may be employed.

An example of an entry-driving plan with four headings is shown in an accompanying illustration (*Coal Age*, February, 1957, p 78). In this instance, the mining unit is a boring-type machine served by three shuttle cars, one a surge unit. Heading advancement is in a definite sequence, as shown by the letters and numbers. The basic plan is to advance the headings in pairs to keep tramming time to a minimum and also keep to a minimum the number of crosscuts in the center pillar.

Another operation using ripper-type machines provides an example of a large number of headings in entry development, to wit: nine for mains. Two machines work in the entry, each being assigned four headings on each side. The center is worked by one or the other machine, depending upon the rate of advance. Using the center as the extra place simplifies keeping the two units abreast. The crew consists of two facemen, whose duties include placing screw jacks under temporary face crossbars, extending curtains, rockdusting and shoveling loose coal to the center of the place; miner operator; pickup loader operator; two shuttle-car operators; utility man; ventilation man, who helps rockdust; one roof-bolter; and one electrician. Average machine output in 55-in coal is 400 tons (raw) per shift.

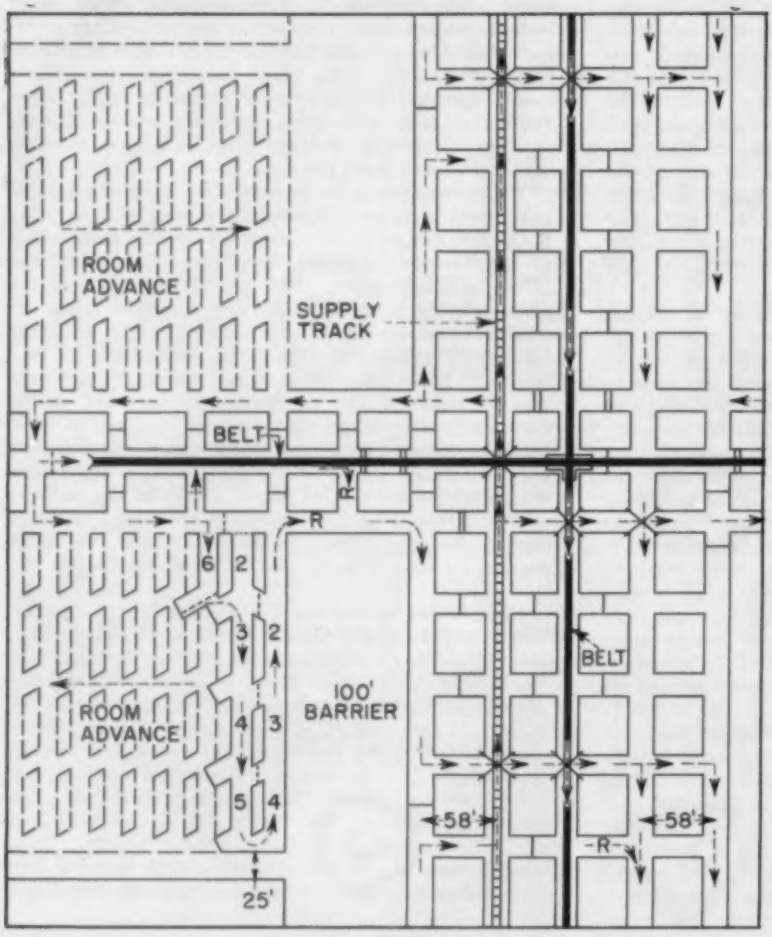
With conveyors, whether loaded by hand or machine, some form of cross unit normally is necessary to bring the coal to one point, for transfer either to a mother belt or mine cars. One layout, based on bridge conveyors (*Coal Age*, September, 1954, p 106), is shown in the accompanying diagram. The cross conveyor brings all the coal to an elevator. Cars are loaded in trips on a loop track, with movement by a hoist. Instead of the loop track, tail tracks for pushing in and pulling out are common in receiving coal for both conveyors and shuttle cars. Frequently, to get the necessary length of tail section, it is turned into a room or through a crosscut, with the elevator on the curve. Loading sections sometimes are paralleled by passing tracks either in the same or parallel headings for greater convenience and less loss of time in changing trips. Trip control systems and equipment are analyzed in the section on transportation.

Crosscutting on Pitches—The making of crosscuts between gangways and airways is one of the most costly and aggravating operations in developing for pitch mining. The big drill—36 or 42 in, or larger—has been suggested and used for this purpose (*Coal Age*, May, 1951, p 100). A new unit (*Coal Age*, August, 1955, p 58) is designed for pulling the big bit by a wire rope through a pilot hole, thus decreasing drill size and also weight to a few hundred pounds. One advantage of drilled crosscuts is the fact that they are small, though still large enough to carry the required volume of air. Consequently, they can be closed with a simple wood or steel disk, rather than an expensive custom-made stopping.

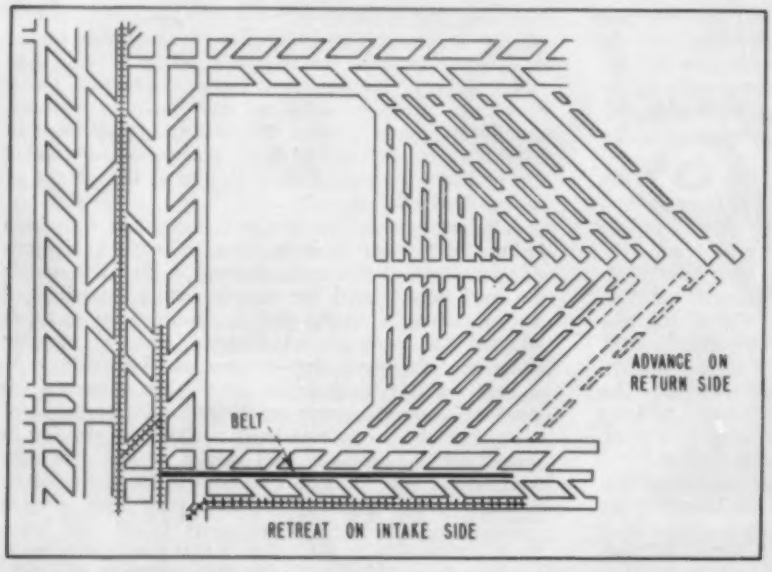
Rock Handling

Where taking rock is a matter of brushing top or lifting bottom in a haulage road, as distinguished from regular tunneling, the tendency is to use coal equipment to save the cost and complications involved in employing special equipment. General practice is to alternate with coal and rock cuts, whether in the top or the bottom. Other operators, however, drive in coal various distances, usually from one crosscut to the next, or some other fixed distance—100 or 150 ft for example—before taking top or lifting bottom. This is facilitated by the use of rubber-tired haulage units.

A balancing of all the factors may result in a decision to haul all the rock made in attaining height to the outside for disposal. However, disposal in the mine avoids the haul outside and the supplementary operation of throwing it away on the surface. Some of the methods adopted for underground disposal are: (1) stowing along the rib where the opening can be made wide enough for this purpose; (2) stowing in crosscuts; (3) stowing in openings made especially for the purpose—for example, stubs driven into barrier pillars; (4) stowing in special gobbing rooms or back entries. At one anthracite operation in light-pitch coal, as an example of the latter, a lower "water gangway" receives rock from a cross conveyor laid through the crosscuts (*Coal Age*, July, 1955, p 74). In flat coal, the fact that the shuttle car is not limited to one opening or route makes it especially useful in stowing in crosscuts or special stubs, rooms or entries.



CONTINUOUS PLAN FOR ROOM MINING ONLY, designed for advance on one side of the panel and retreat in the other. Note crosscutting in first two rooms to establish ventilation.



ANGLE CONTINUOUS PLAN, ROOM MINING, shuttle-car and belt haulage. Rooms are worked advancing on the return side of the panel and retreating on the intake.

Continuous

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Continuous Projections . p 34
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CONTINUOUS MINING replaces explosives with electric power applied through a bit to break the coal. As a result, cutting, drilling and shooting are eliminated and with it most of the men required for these operations. The bit, however, becomes a key item because the ability of the bit to stand up under the strain is the main thing that makes continuous mining with mobile machines—and with most other types—possible.

Bit cost consequently becomes a sizable item, in turn reflected in increased stress not only on the design of the bit itself but on holders, speed with which the bit is presented to and pulled through the coal, and so on. It is this area, as well as in higher-strength alloys for shafts and the like, and better insulation for motors to permit rating them up, that continued research will pay off as it already has in advances made in the past 5 yr or so.

These advances have made possible outputs per shift comparable to those attained by conventional loading units, in turn alleviating to some extent the transportation problem. The intermittency of previous transportation methods, and consequently their inherent inability to provide continuity of operation, was obscured by the relatively high capacity of modern loading machines. When the original low-capacity miners came out, this transportation deficiency became glaringly apparent. Prior to the development of today's conveyor equipment, including the extensible types, efforts to achieve a reasonable degree of continuity and thus boost output included surge cars and pickup loaders. The latter still are fairly widely employed.

Basic Needs

Provide as near continuous transportation as possible.

Set up all other service functions so that all possible delays or burdens on the miner are eliminated.

Mining

SUCCESS WITH CONTINUOUS MINING, like success with machine loading and other forms of mining, requires that stress first be laid on what goes on before and behind the machine. After that, attention can be devoted to the way the machine is operated, though with many types of miners if supporting services are good about all that is necessary is to turn it loose.

Prerequisites to successful continuous mining (*Coal Age*, May, 1957, p 70) include the following:

1. Development of a Suitable Mining System. Mobile-type continuous machines in the United States are designed for use in room-and-pillar systems, and work quite successfully in such systems. Widths, centers and the like, however should be modified, if possible to conform to the characteristics of the machine selected. The trend apparently is toward 90-deg work and complete pillar extraction, though a fair number of angle plans or mixed square and angle plans are employed.

2. Roof Support Without Hindering Production. Bolting units on miners are one answer. Alternating places, or alternating lifts in a place with rigid-head units, to permit timber advance in stages of, say, 20 to 25 ft, are others.

3. Adequate Ventilation. Because speed of advance increases gas emission and dust formation, positive means must be employed—brattice lines, auxiliary fans, etc.—to keep the face clear and gas and dust below the hazard levels. Yet too much air results in discomfort. Spraying and rock-dusting become much more important. Also, as a result of higher gas and dust formation, care must be taken to insure good rockdusting in return airways. New types of filters, incidentally, offer the possibility of trapping the dust as it is made in an economical unit that would not be unduly bulky.

4. Continuous Transportation. Haulage is perhaps the most critical of all factors in continuous-mining results. It should be as nearly continuous as possible. New types of conveyors are among the developments providing a closer approach to 100% continuity.

5. Well-Trained Men. This includes all men connected with the operation of the unit, including bolters, supplymen and so on. A thorough understanding of the job, and of the pro-

Trend Markers—Continuous Mining

Continuous mining moving rapidly, with new high-capacity machines providing tonnages equal to those from good loading-machine setups with one-quarter to one-half less men.

Boring units finding rapidly increasing acceptance.

Shortwall and planer-type mining-and-loading units growing in thin coal, and are being joined by new low-type mobile machines, thus giving the low-vein operator a much wider choice of equipment.

Conveyor transportation with bridge and extensible units growing rapidly.

Full retreat in panels more common with advance on one side and retreat on the other equally popular. Bleeder openings incorporated in practically all plans. Right-angle or 90-deg plans most common even with fixed-head or semi-rigid continuous miners. Pillaring scheduled for almost all continuous mining setups, with open ending a fairly popular system.

Production with ripper-type continuous units proved feasible in two bituminous operations with pitches up to 15 deg.

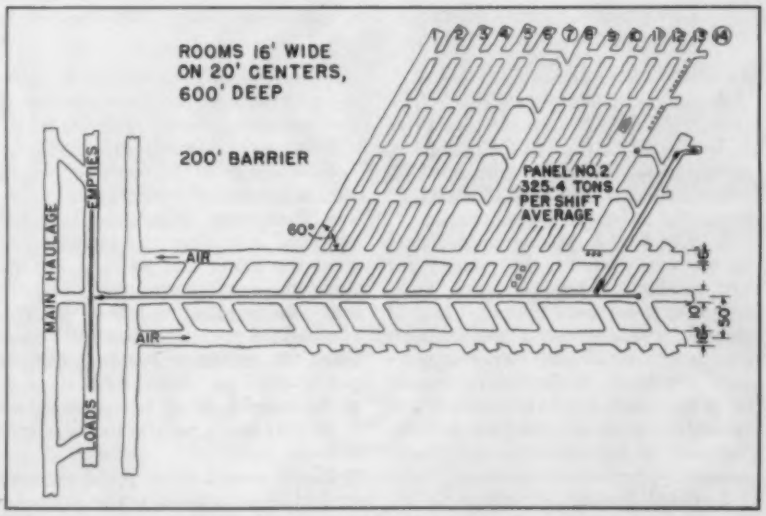
Future Possibilities

Level Coal

A major expansion in the use of remotely controlled boring-type miners, reflecting in part design of control units for application underground. These, in low-height designs, may be one answer to the problem of continuous mining in coal under 3 ft in thickness.

Pitching Coal

More use of continuous machines in light-pitch coal after development methods are changed to accommodate them; more longwalling in light pitch with longwall-type continuous miners.



ANGLE CONTINUOUS PLAN, ROOM MINING, with extensible belt for haulage, advance on one side and retreat on the other. Places are 600 ft deep.

Case-Finder—Continuous Mining

Preparing for Continuous Mining—Machine selection, mining plan, roof support, ventilation, power, coal haulage, manpower, supplies, maintenance, effects on preparation. *Coal Age*, May, 1957, p 77.

Development With Continuous Units—Two ripper-type machines advance nine headings abreast and average of 750 ft per month, two shifts, 55-in average thickness. Pickup loaders and shuttle cars deliver to belts. *Coal Age*, May, 1957, p 84.

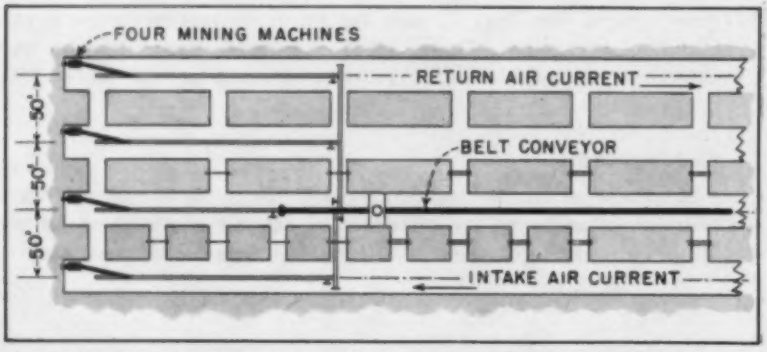
High Tonnage With Small Crews—Three men with semirigid miners average over 200 tons per shift in 7 ft of coal, 10-ton shuttle cars, two-pass solid work, open-end pillaring. *Coal Age*, September, 1956, p 60.

Pillaring With Continuous Miners—Open-ending, splitting, pocketing and special plans for both square and angle work with all types of machines; special plans for new-type miners and transportation equipment. *Coal Age*, October, 1956, p 72.

Pillaring With Continuous Machines—Panels laid out for loop haulage, main-entry pillars recovered in final extraction, individual pillars recovered open-ended. *Coal Age*, March, 1957, p 58.

Western Pennsylvania Practice—How one type of miner is used to develop places and mine pillars in seven operations, including recovery of standing pillars in old sections. Average raw output per shift, 190 tons; minimum, 155; maximum, 240. Average tons per man, 45; average reduction in face labor, 52.5%. *Coal Age*, April, 1957, p 70.

Boring-Type Units—Six machines making openings 13 ft 2 in. wide and 7 ft high average 458 tons of clean coal per shift. Panels now designed for rope-type extensible belts. Rooms driven in pairs and pillars mined by pocketing on 45 deg. *Coal Age*, February, 1957, p 76.



ENTRY-DEVELOPMENT PLAN with auger-head miner in 36-in coal.

duction goals to be reached, are vital.

6. A Good Supply System. The penalty when a continuous unit stops is, by the very nature of the operation, more severe. Steps therefore must be taken to make sure lack of materials is not the villain in any stoppages.

7. The Best in Maintenance. Since, as previously noted, the penalty for lost production time is much more severe in continuous mining, the goal should be a preventive maintenance program that will keep such stoppages to a minimum. It necessarily should be supplemented by an overhaul and rebuilding program designed to keep the unit in top condition and make preventive maintenance easier.

8. Good Power. DC still is the almost universal power in coal mining. The rule is rated voltage at the motor terminals when the machine is operating at normal rate. Development of the torque-converter and AC-drive shuttle cars undoubtedly means a rapid upsurge in AC systems, which offer a number of advantages.

9. Production Standards. Last but not least is a clear understanding of what the miner and its crew can do under the conditions normally prevailing. This requires the determination of standard operating times and from them the setting of standard outputs per shift. The major tool is time-study, supplemented by operating reports that relate results to the standards set.

These and other problems are treated in more detail in the following and in other sections of this 1957 Mining Guidebook.

Continuous Projections

Match mining plans to machine characteristics as closely as possible, but particularly to the type of transportation equipment employed.

Be prepared to change plans to take advantage of new types of transportation equipment, including those that are still only ideas or have not yet been thought of.

Plan to get all the coal, which means pillaring if reasonably possible.

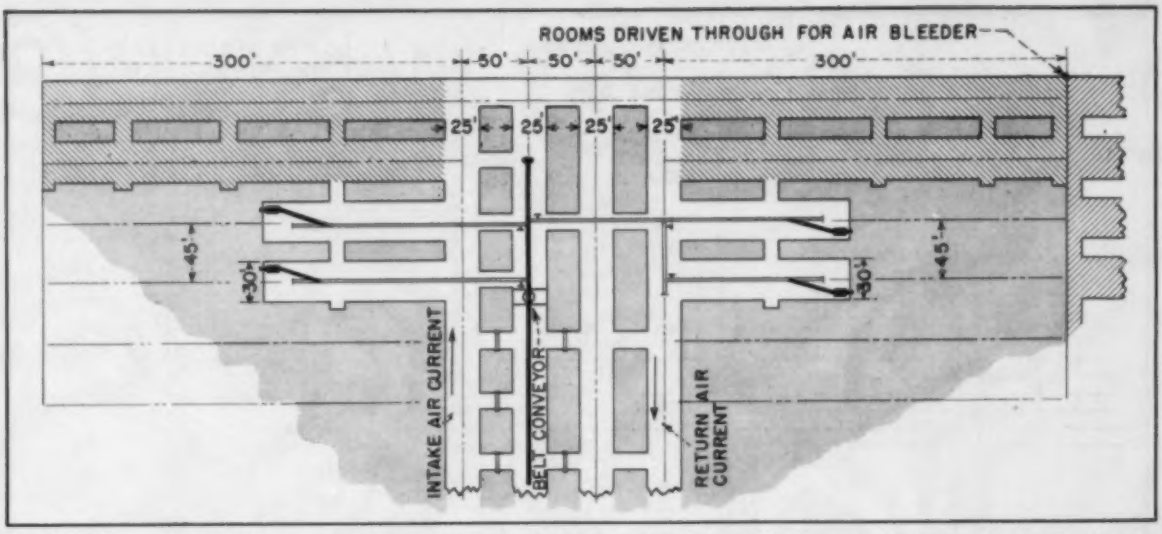
CONTINUOUS MINING is beginning to come of age in the United States, although much experimental and development work remain. Nevertheless, continuous mining is beginning to enter the stage of reliable production at relatively high rates.

The possibilities and limitations of continuous machines also are becoming clearer. This accounts for one mine now limiting continuous units largely to entry driving, one reason being that their reach makes them more suitable for narrow places, whereas conventional equipment can better cover the wider faces encountered in room work. There are other reasons for limiting continuous machines to certain areas or for taking them out completely and going back to conventional units. One is the presence of thick bands or a number of thin hard partings. Another is heavy pyrites intrusions, running up bit cost. However, in the normal course of things, miners must be prepared to tackle a moderate amount of material other than coal, and the majority do fairly well—at the price of some temporary increase in bit cost.

As with earlier mining equipment, the emphasis in the United States has been on mobile machines, even though the actual mining principle ranges from ripping to boring. As a result, most of the continuous production comes from room-and-pillar or block systems, modified as necessary to take fuller advantage of the potentialities of the miner—and more recently of the new types of conveyors.

The mobile design of practically all mining-and-loading, or "continuous," machines used in the United States and Canada has resulted in projections very similar, for the most part, to those previously employed for conventional loading and, earlier, for hand loading. Certain exceptions, used with special equipment, such as the planer, are discussed in the "Longwall" section of this article.

Even though the plans are gen-



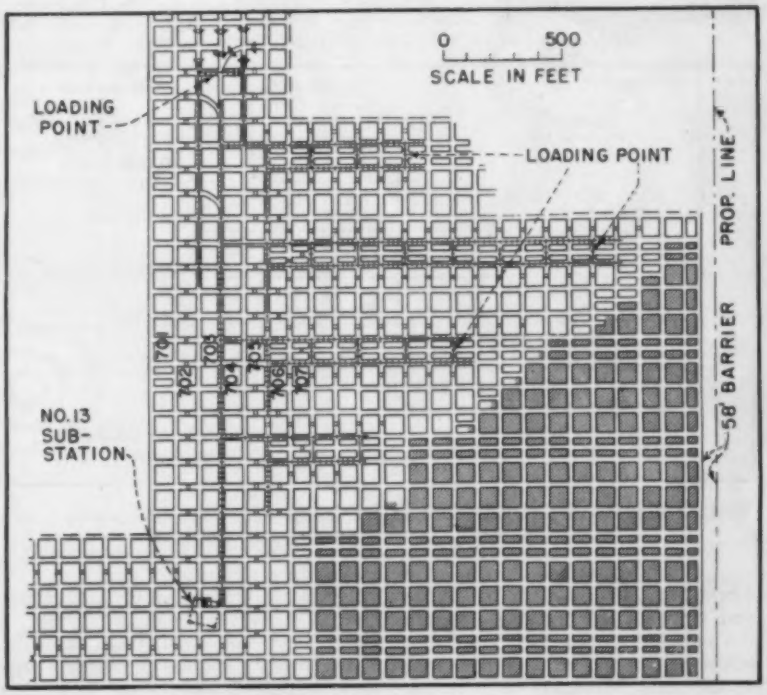
PLAN FOR AUGER-HEAD MINER feeding to bridge and room conveyors. Entries are first advanced to the limit and then rooms are brought back two abreast on each side. To increase pillar recovery, the room may be slabbed on the retreat.

erally the same, mining with continuous units differs basically from mining with earlier equipment in that the continuous machine can stay in one place, compared to loaders, for example, and can produce "continuously" from that place, compared to the intermittent production from, say, conveyor places, where the need for cutting, drilling and shooting, even though overlapped with each other and with loading as far as possible, necessarily cannot be arranged so that loading is continuous.

This ability of the continuous miner to get all its tonnage from a single place has, among other things, eased the problems of entry-driving and development in at least some respects, as outlined in the previous section on opening and development.

Continuous equipment also provides an opportunity for a concentration of production previously impossible to attain. As an extreme example, all the machines necessary for the desired output per shift may be stationed in adjoining places, and the places may be either rooms or entry headings with no significant difference in output, other things being equal. One bar to heavy concentrations, however, might be the corresponding increase in the rate of gas liberation, which might make it difficult to get enough air to the points of coal production to keep the percentage below safe limits at all times. High concentration also may add to the difficulties of providing continuous haulage, handling men and supplies, rock-dusting and so on.

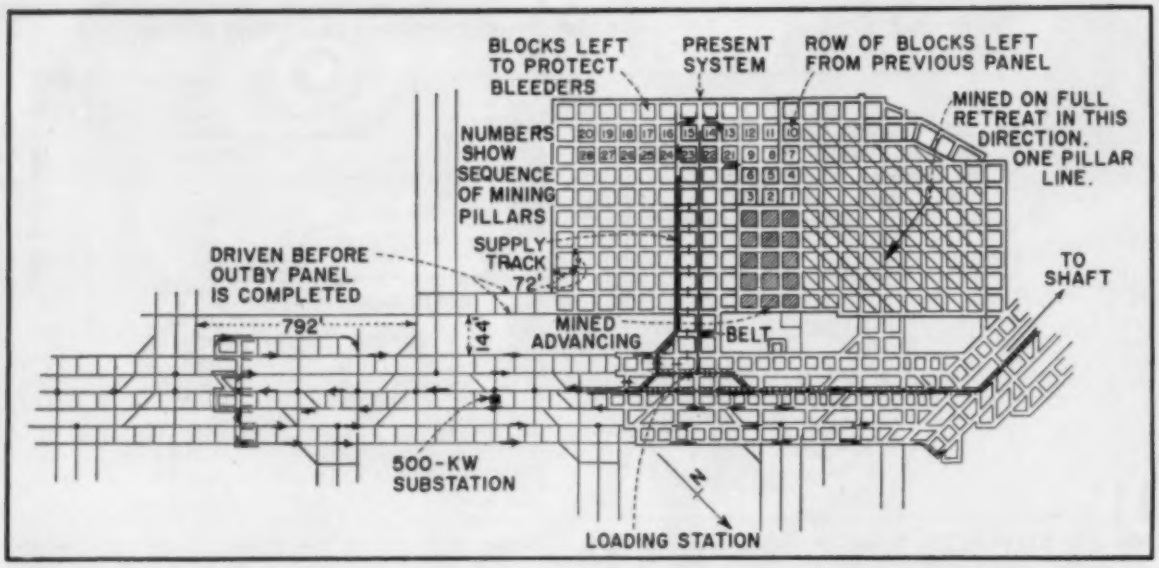
With conventional forms of transportation, such as, shuttle cars or standard room conveyors, "room" depth necessarily is much the same as with conventional equipment. New transportation units, on the other hand, such as, the articulated and extensible belts, permit changing projections to provide for "room" lengths up to 1,000 ft. Thus, along with the fact that the continuous unit simplifies the entry-driving phase of development, even fewer entries are necessary with the long rooms.



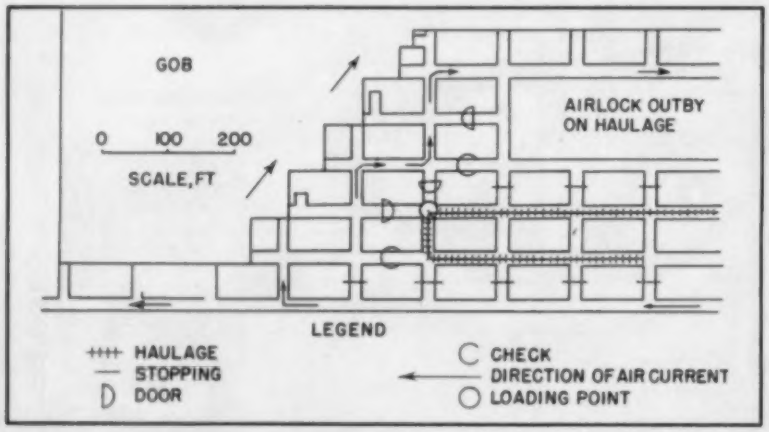
BLOCK-TYPE CONTINUOUS PLAN with stepped pillar line. Loop-haulage system eliminates car-change delays at loading points.

Room Systems

An example of 90-deg continuous mining with ripper-type machines, leaving thin pillars, is shown in an accompanying illustration. Using shuttle cars and belts, the rooms are mined on the advance on one side, and on the retreat on the other. One feature of this plan is the establishment of the crosscutting pattern with the driving of the first two rooms, as shown.



ADVANCE ON ONE SIDE OF THE PANEL and retreat on the other features this continuous-miner plan, which has a minimum of open territory. Rooms are driven on the advance on the return side and the pillars recovered. Recovery is 85 to 90%.



"SHORT-ROOM" CONTINUOUS PLAN with rectangular pillars and machines with semirigid heads. Loop track facilitates haulage.

Thereafter, the crosscuts are turned and driven pillar thickness deep on the solid side, while those on the opposite side are picked up automatically as the place advances.

To facilitate shuttle-car haulage to panel belts another user of ripper-type equipment turned places on a 45-deg angle, and omitted every 6th or 7th room to form a squeeze pillar and barrier. Rooms are turned both ways from the three-heading panel entry which leaves a triangle between the outby ends of adjacent sets of entries. This triangle is mined by turning sub-rooms, again at 45 deg, off the No. 1 room on each side. The panels are "closed" in that they are surrounded by solid pillars except where the panel entries come in. Rooms are worked on the return side of the air current on the advance.

A modification of this system to permit using the extensible belt consists mainly of making the rooms 600 ft long. The three headings making up the room entry are driven with shuttle cars, with cross cuts at 60 deg from the belt heading. Each of the six rooms in a group is driven separately, advancing on the return side of the panel and retreating on the intake side, as shown in the accompanying plan. In addition to heading advancement, shuttle cars are used in making chutes across the chain pillars, and for recovering timber (see Room 12).

A plan for the auger-head miner, as shown in the accompanying illustration, is based on earlier conveyor setups. As shown, the entry is first driven up and the rooms are mined retreating, with two miners and accompanying bridge and room conveyors on each side. In entry development, coal from the three side places in the four-heading setup is brought to the mother belt by cross conveyors. (*Coal Age*, March, 1956, p 66.)

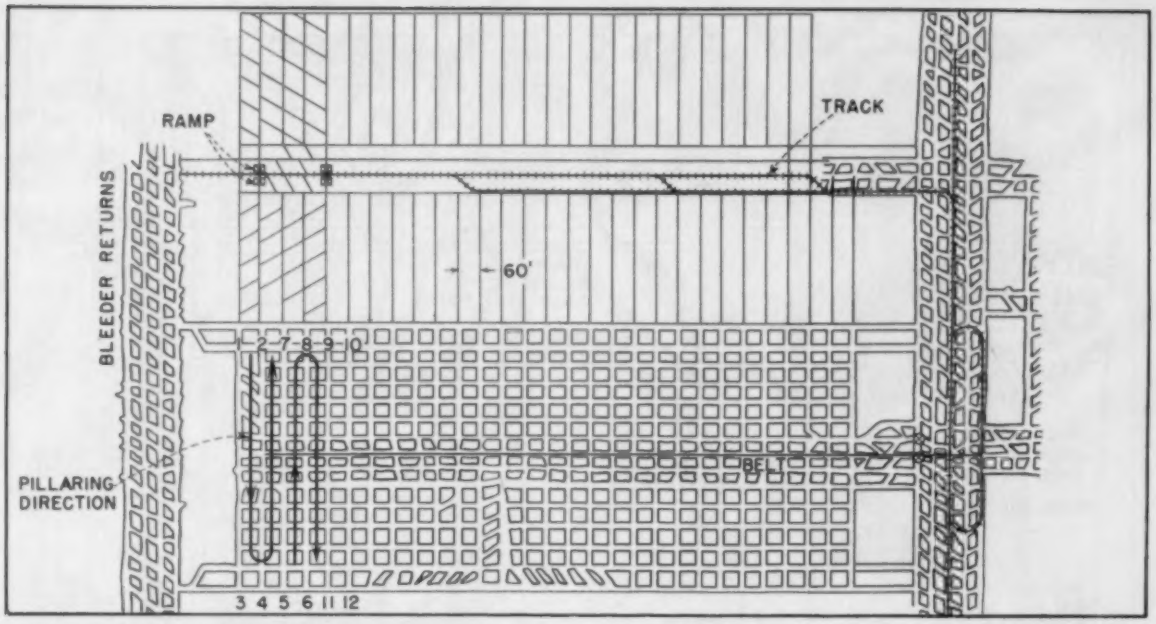
Pillar Systems

Projections for continuous pillar-mining systems, as for room systems, are, as previously noted, fairly similar to those for machine and hand loading. The big deviations occur when the extensible belt is employed.

Flat pillar lines are more common though the old reliable angle line still is found. The tendency, however, in 45-deg or other angle lines is to put steps in them. An accompanying block plan is an example. As will be noted, the steps usually are not over three or four blocks, and in many plans are only two or three.

Steps in lines pose the same problems of weight on projecting points as weight or stumps in a standard 45-deg line (see "Machine Projections" in the following section on machine loading). However, many operators are finding them helpful as well as satisfactory where top is good and weight on the points is not excessive.

Following through on the similarity between continuous and conventional plans, full retreat in a panel, or advance one side and retreat the other, is a common system with continuous



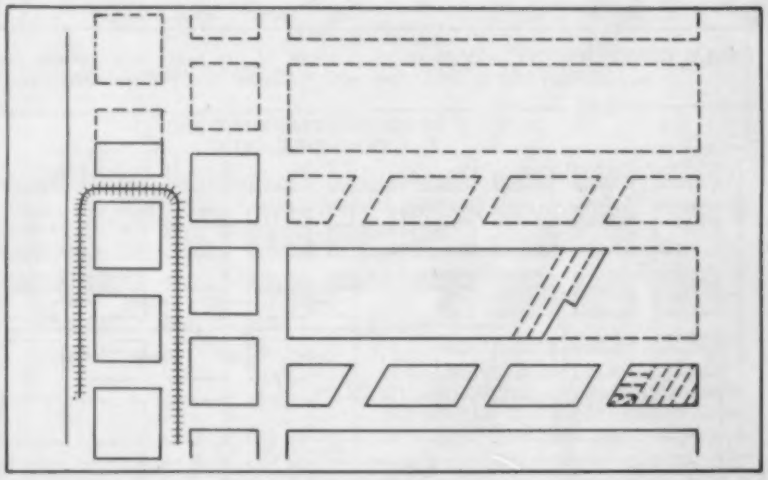
CRISSCROSS PILLAR EXTRACTION features these plans for operation with rigid-head miner and belt or rail transportation. They include a special bleeder heading at the tops of the panels for more-efficient one-way air travel and emergency escape.

equipment. An example of the latter is shown in an accompanying plan, also featuring bleeder openings. In this plan, three rooms are driven through to the previous bleeder. The pillars between Rooms 1 and 2 then are removed. Two rooms always are kept open ahead of the advancing pillar line by driving a new place as each line of pillars is completed. Thus mining alternates between rooms and pillars. When the top of the panel is reached, the pillars are brought back retreating, leaving blocks as indicated to preserve the bleeder openings.

A recent plan for a semirigid head machine is shown in another illustration. In addition to a loop track for receiving coal from the shuttle cars, this plan is distinguished by the fact that the "rooms" are short and that there is no basic difference between development and room work. The rectangular pillars are recovered by pocketing across the ends.

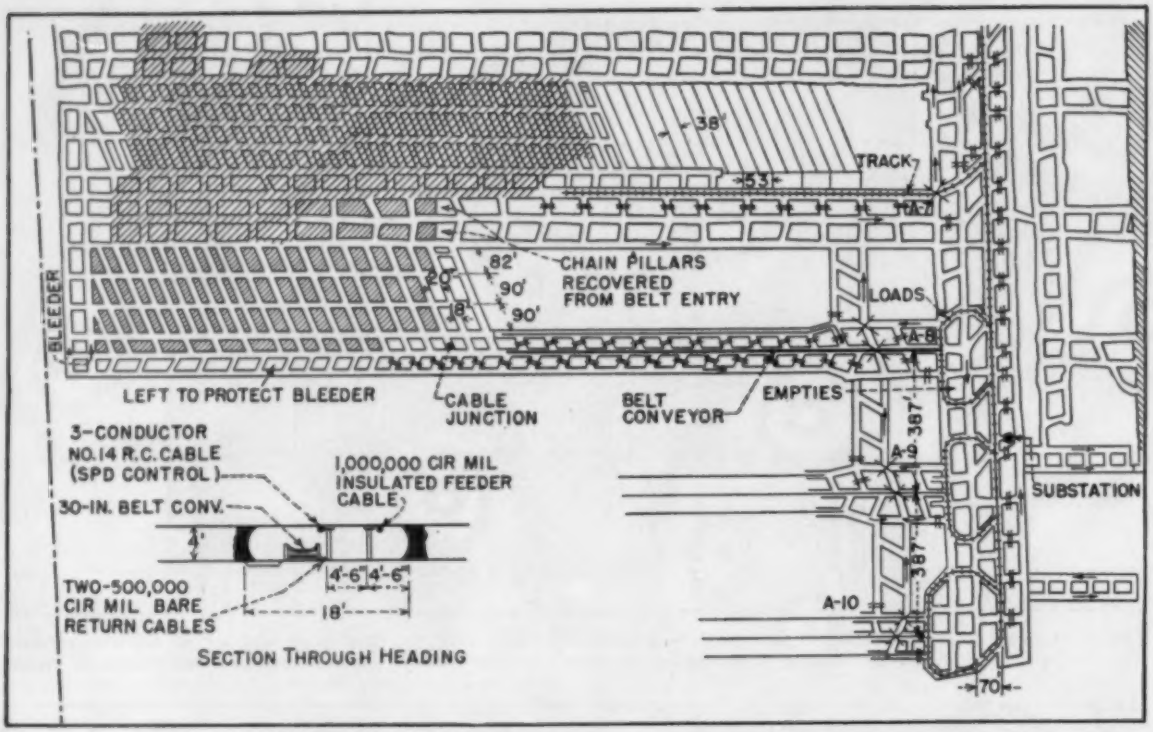
Even with the so-called "rigid" machines, the tendency is to put continuous mining work on 90 deg. An example (*Coal Age*, February, 1956, p 90) showing initial and subsequent panel development in a mining area, as well as haulage setups using both panel belts and track is given in an accompanying illustration. Like many other systems it features bleeders, including a special bleeder heading at the tops of the panels.

Angle plans for rigid-head machines include the one shown in an accompanying illustration (*Coal Age*, June, 1956, p 78). Haulage is by shuttle car to panel belt to cars on loop track at the mouth of the panel. As indicated, the popular bleeder openings are provided. The coal is thin and the rooms are driven on short centers to narrow the pillars. The miner alternates from one to another of two rooms each time it reaches a crosscut. When a room is completed the pillars are mined by open-ending.

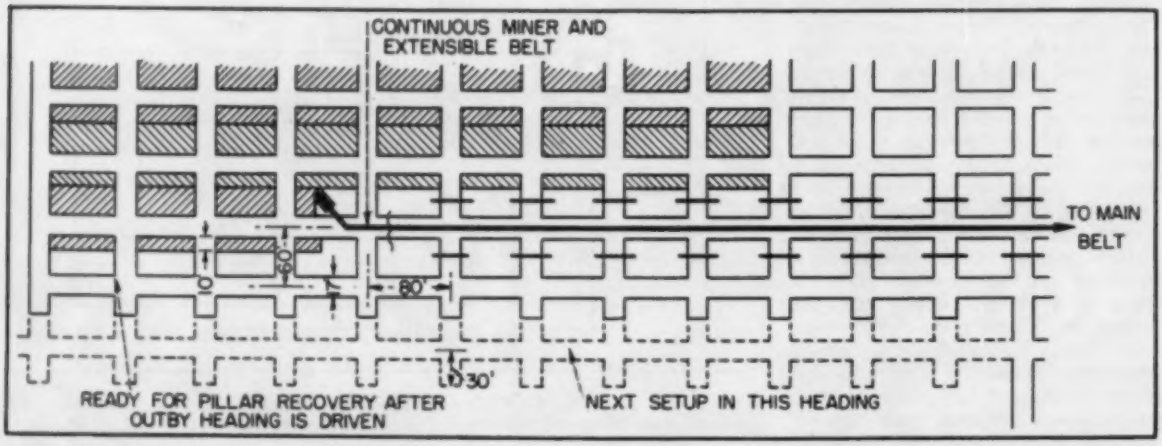


ANGLE PILLARING PLAN for rigid-head miner is based on solid pillars between pairs of rooms. Recovery is accomplished by open-ending with posts and breaker sets.

Extensible-Belt Plans—An early plan designed to make use of the extensible belt, with ripper-type equipment and pillaring, is shown in an accompanying illustration. It is designed for driving places 1,000 ft deep, for mining the pillars in two stages, and for keeping an open place equipped with belt and conveyor stands ahead of the one in which pillaring is being done. This latter practice speeds up movement from one place to another, although it does require extra belt and conveyor. The sequence of operation is to take 10 ft off the pillar on the left and the remainder of the pillar on the right, shortening the conveyor and moving it out as the room is shortened. When this room is completed, the miner leapfrogs the next room and drives the third one up. The miner and the head and tail sections are then



ANGLE DEVELOPMENT with rooms on one side of the panel only features this retreat-mining plan for rigid-head miners in medium-thickness coal. The plan includes bleeders and loop tracks for handling main-line trips.

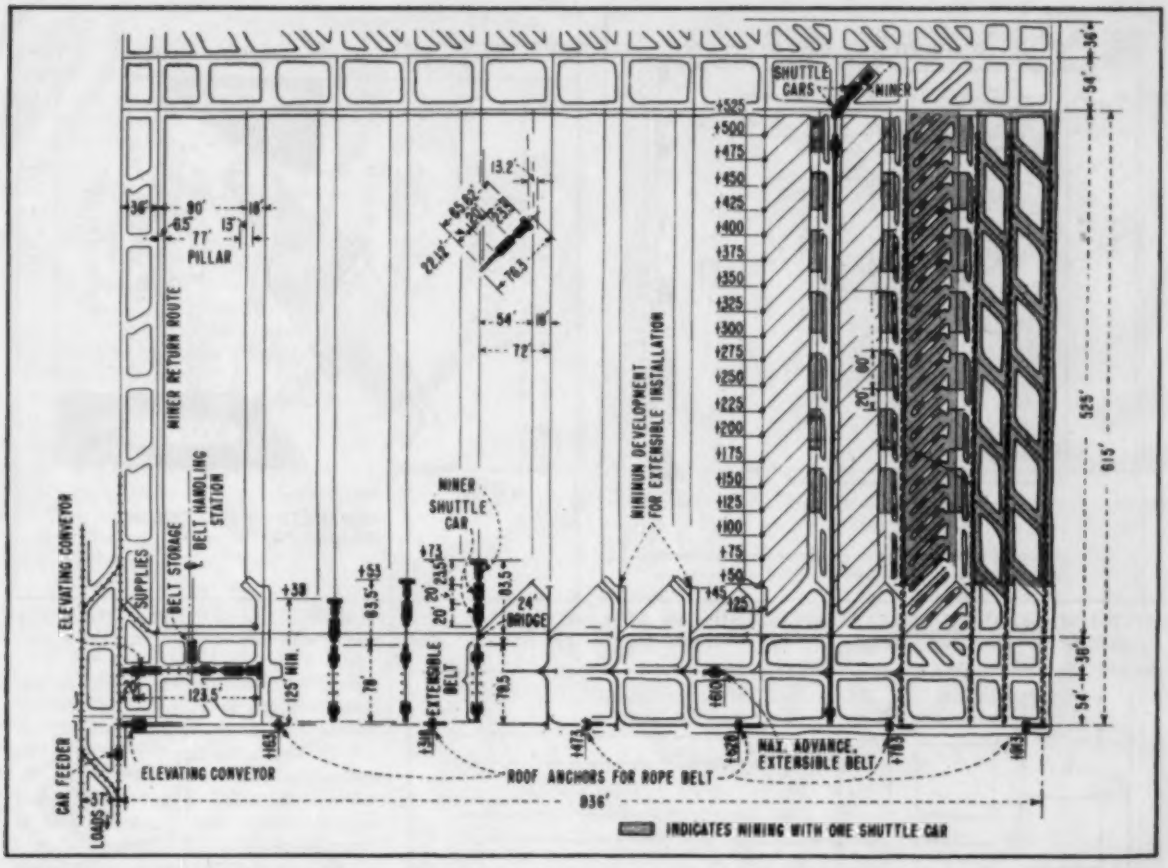


EXTENSIBLE BELT permits driving places 1,000 ft deep with ripper-type continuous miner. The pillaring plan shown is one designed to take advantage of extensible-belt characteristics.

Extensible Belts Permit Driving Much-Deeper Places

moved back to No. 2 and the pillaring procedure (10 ft on one side and the remainer on the other) is repeated.

The rope-type extensible belt is the transportation tool in a recent plan for a boring-type miner (see accompanying illustration). Rooms are 500 ft long in this plan and the chain pillars in the previous panel are taken by using two shuttle cars in tandem to close the gap between miner and belt end. The principal mining operation is in pairs of rooms driven on short centers to leave a thicker pillar against the pair previously mined out. This latter pillar is mined out by pocketing across the end on a 45-deg angle, leaving a 5-ft fender against the gob. Pockets through the fender, and through the thin chain pillars, complete the extraction. The bleeder principle is observed by cutting the first pair of rooms at the inby end of the panel into the old works.



ROOMS 500 FT DEEP are worked in pairs with thin pillars between rooms and thick pillars between pairs. Rope-type extensible belts permit increasing room depth to 500 ft. Thick pillars are mined by pocketing through on a 45-deg angle.

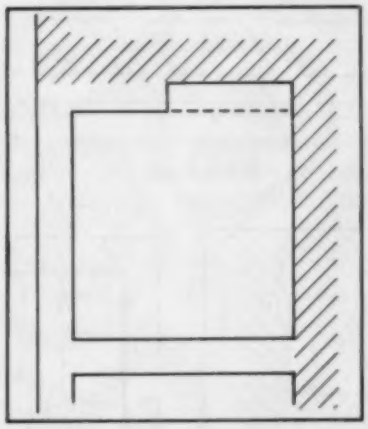
Pillar Plans

Consider open-ending for simplicity where roof and other conditions permit.

Consider splitting and pocketing where support problems may be greater than average.

PILLARING with continuous miners is not too different from pillaring with loading machines, or farther back, pillaring with hand loading. One reason, perhaps, is the fact that transportation equipment as yet is not radically different. As new transportation units—the bridge conveyor and the extensible, as examples—find wider use the pillaring system may undergo radical change. The two extensible-belt plans briefed in the immediately preceding section of this article are examples of how practice may evolve.

Coal mining in the past quarter century has been marked by a slow increase in the use of block systems. The trend seems to have been accelerated by the advent of the continuous machine, which was accompanied by an increased need to get all the coal possible in view of rising costs.



CONVENTIONAL OPEN-ENDING for blocks and rectangles.

Blocks can be diamond-shaped and also equal-sided. However, the tendency is to apply the term "block" to any pillar that is more nearly square than rectangular.

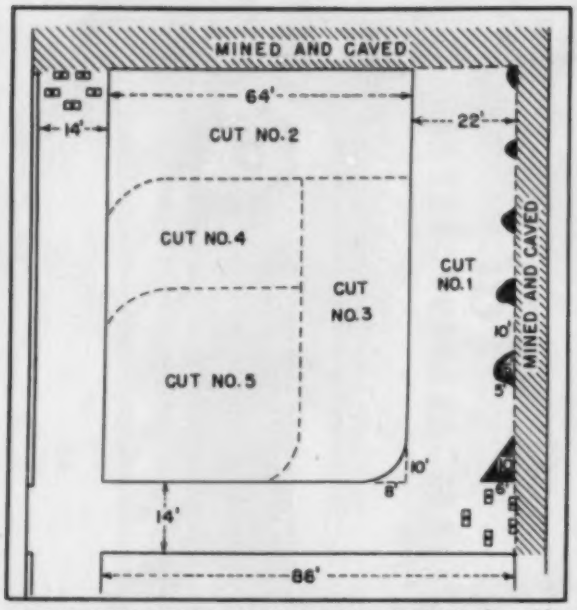
One plan of pillaring with continuous mining is based on 85x85-ft blocks. The majority, however, run from approximately 60x60 to 70x70 ft. The smallest is 45x45 ft with rare exceptions.

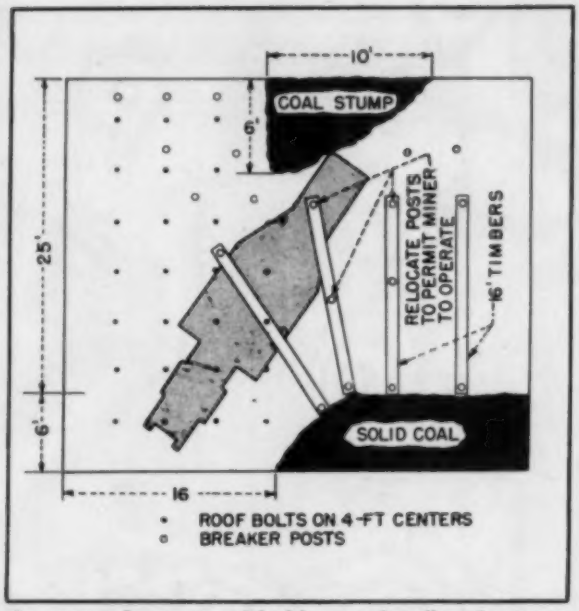
Establishing the size of the block, or the conventional rectangular pillar, involves, among other things, choosing between the risk of roof deterioration and other troubles in driving long pillar lifts, and the extra trouble and cost, if any, of establishing new lifts, including any extra timbering at the mouth of the lift and additional time in jockeying to get the lift started. If the plans developed to date are a reliable indication, the most desirable length of lift, in the absence of special conditions, is 60 to 70 ft.

Very thin pillars are provided for in some plans for both flat and pitching coal. One goal is fixing it so that the miner can reach through them with a minimum of timbering in addition to the regular room timbering and perhaps a crossbar or extra post at the mouth of the lift.

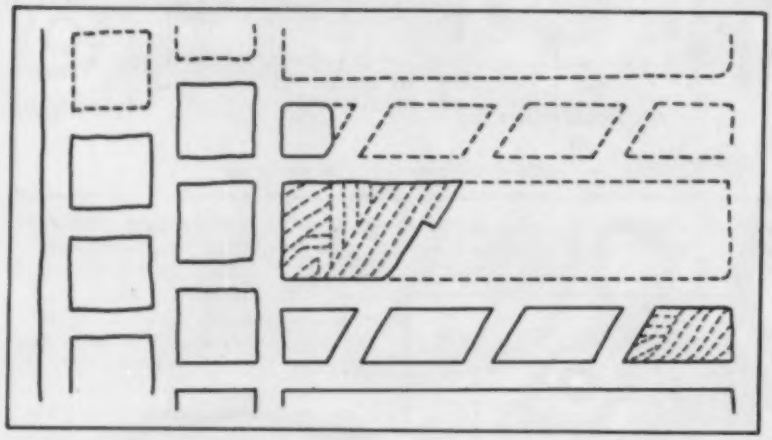
Open Ending

The speed with which a lift can be





OPEN-ENDING WITH SMALL COAL STUMPS for additional support and protection of the lift across the pillar. The stumps supplement roof bolts and crossbars. Ripping-type machines are employed for the mining operation in thick coal with drawslate top.



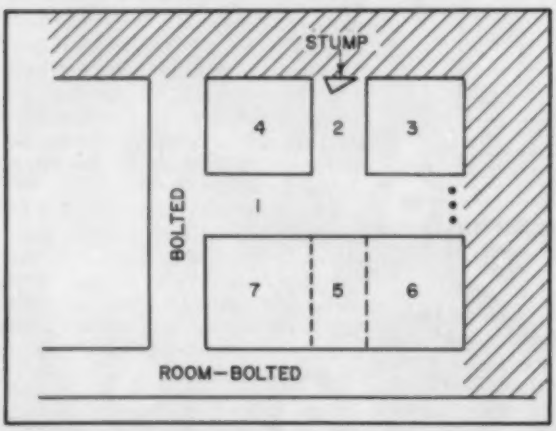
ANGLE OPEN-ENDING combined with 90-deg development. Solid pillars between pairs of rooms provide much of the tonnage.

mined with continuous machines has been one of the factors contributing to the increase in open-ending of pillars. This eases the support problem enough so that opportunity can be taken of the other advantages of open-ending. One is that open-ending is, in many respects, much simpler not only in driving the lift but in ventilation and ease of maneuvering equipment.

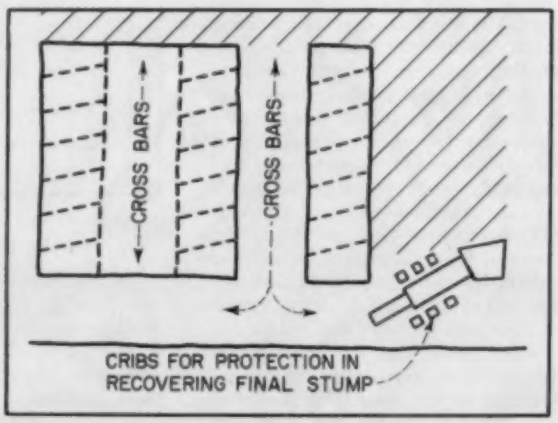
Mines using open-ending or modifications include the following:

1. Thick coal, 18 to 24 in drawslate, 12 in top coal left. Ripper-type machines used to recover old room pillars. Support in 12-ft wide lifts provided by 5x6-in crossbars on 5-ft centers, with special 15-ft-long bars at intersections.

2. Thin coal, 42 in, excellent top.



CONVENTIONAL SPLITTING PLAN leaves big stumps on the corners for the final recovery operation.



WINGS ARE OPEN-ENDED in this splitting plan using cribs to protect the miner in final stump recovery.

Semi-rigid machines, 45x45-ft blocks, support rarely required.

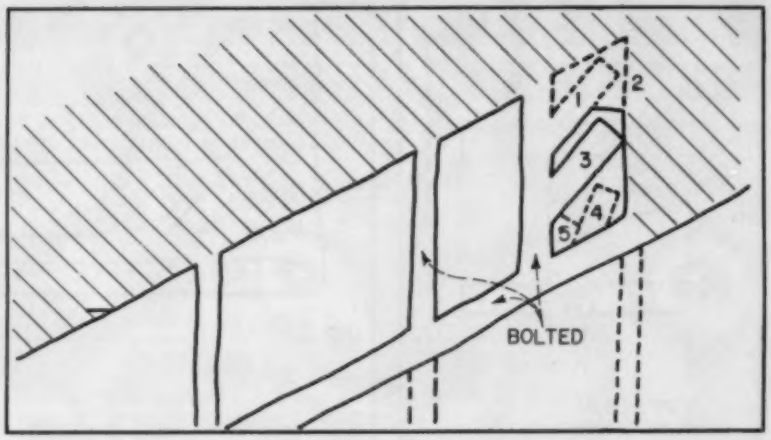
3. Thick coal, 7 ft recovered, 1 ft left against fair to bad top. Ripper-type machines, 80-ft blocks, posts and crossbars.

4. Thick coal, soft gray shale top. Rigid-head machines, 52x52-ft blocks, post normally used for support in lifts.

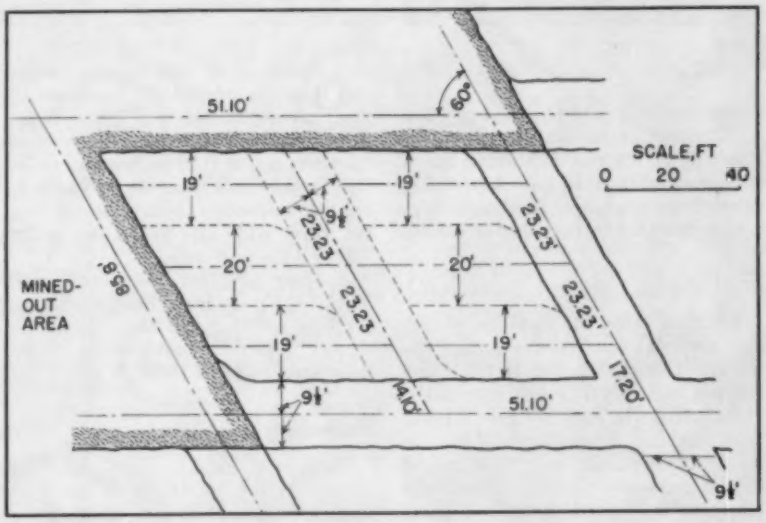
5. Thin coal, 48 in average, weak to fair top. Angle plan (see illustration) with rigid-head machines. Pillars 20 ft through. Support by posts along gob edge of lift and at the face.

Modifications of the open-end plan include leaving pegs or small stumps of coal on the gob side at the start of the lift for extra support. Another variation is taking two or three lifts and then leaving a wing or fender, say 6 ft through, to break the top and protect subsequent lifts.

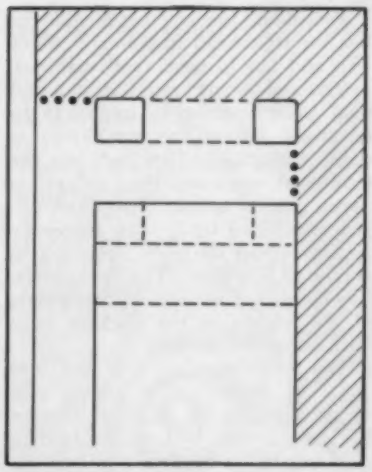
A combination of solid and conventional room pillars characterizes another modification for rigid-head machines also illustrated. This plan also shows one method of combining 90-deg development with angle pillaring in rooms. The top is a medium-hard shale over which is laminated shale and coal. Rooms 16 ft wide are driven on 50-ft centers, leaving solid pillars 59 ft thick on the gob side. These solid pillars are recovered by open-ending on 45 deg, using posts along the gob edge of the lift. Clumps of posts on close centers are interspaced with posts on regular centers as necessary. Room pillars then are extracted in the same manner. Room and pillar centers were arrived at after several trials, and provide maximum lift length commensurate with rate of roof deterioration and other factors, in-



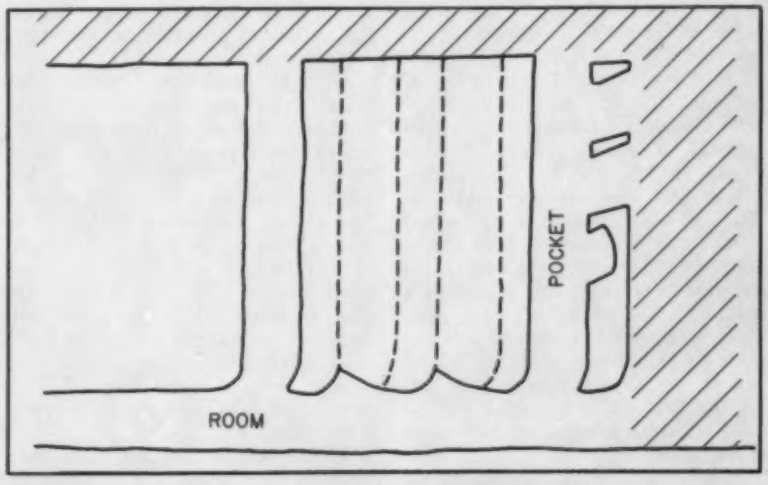
SPLITTING PLAN for diamond-shaped block is followed by making 38-ft-long open-end lifts 19 to 20 ft wide for final recovery.



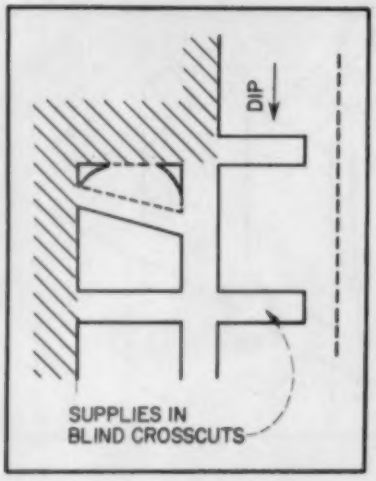
WINGS IN ANGLE PLAN are mined after initial splitting by pocketing in five successive stages, rigid-head machines.



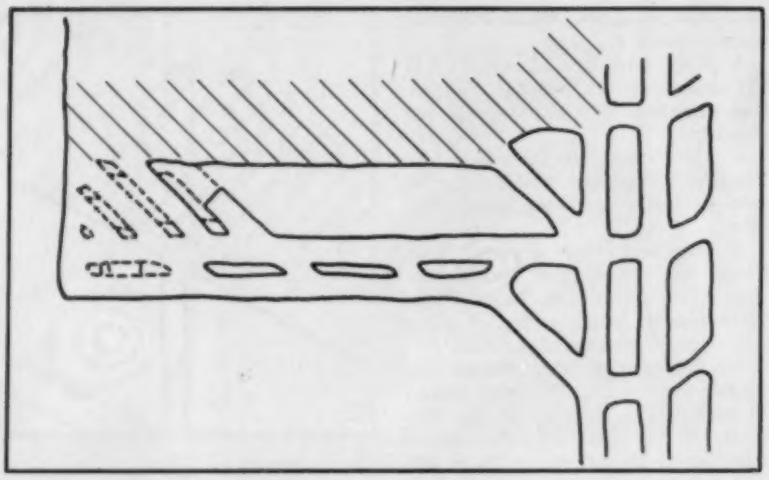
POCKET- AND WING PLAN of the conventional type with corner stumps.



WINGS in this pocket plan are mined by subsidiary pockets, leaving small stumps for protection in the final extraction process.



POCKET DRIVEN ON SLANT is employed in pitch-mining plan.



ANGLE POCKETS with thin fenders distinguish this plan of mining with basic development on a 90-deg angle with rigid-head equipment.

cluding cost of preparing for new lifts.

Auxiliary support by leaving small coal stumps at intervals in the characteristic of the modification of open-ending employed at one mine using ripper-type machines. As shown, support is provided by bolts and crossbars.

Splitting

Splitting plans for continuous miners include the conventional one shown. The coal is 8½ ft thick and the top normally is a soft gray shale. Falls are fairly easy to get. Ripper-type machines drive places 14 ft wide for 58x58-ft pillars, which are mined in the sequence shown. Rooms and crosscuts are bolted. Props and small pegs or stumps are used for support in the pillar openings.

Modifications of the splitting plan include open-ending of the pillar halves at one mine (illustration). Average coal thickness is 60 in. The top is 12 in of drawslate and includes kettlebottoms, slips and horsebacks. Semirigid machines drive rooms and crosscuts 17 ft wide to form 56x53-ft blocks, which are split lengthwise. The halves then are open-ended in lifts 9 ft wide. Support in rooms and crosscuts is by crossbars held up by bolts. In pillar splits, the end of the bar next to gob-side half is held by a bolt, with the other end on a post. Thus interference is reduced and the posts act as breakers when the second half of the pillar is removed. In taking the final lift in removing a pillar half, cribs are erected on both sides of the miner.

A splitting plan for diamond-shaped pillars and rigid-head machines is shown in another illustration. A similar plan also is used with square blocks and ripper or rigid-head machines at other mines. Rooms and crosscuts are driven to form 60x70-ft pillars. Coal thickness is 4 to 6 ft, with a firm shale top. Rooms and crosscuts are bolted, but fast extraction permits completing the 9½-ft wide lifts in the two pillar halves with post only.

Another plan for diamond-shaped blocks, using semirigid head machines, involves splitting the block along its shorter axis and then driving 38-ft-long open ends 19 to 20 ft wide.

Pocketing

Pocketing differs from splitting mainly in the thickness of the coal strip left against the gob, whether the strip be called a fender, a wing or by some other name.Some use the term fender when the pillar is thin—under, say, 3 ft in thickness. Wings, under this system of terminology, therefore are pillars thicker than 3 ft.

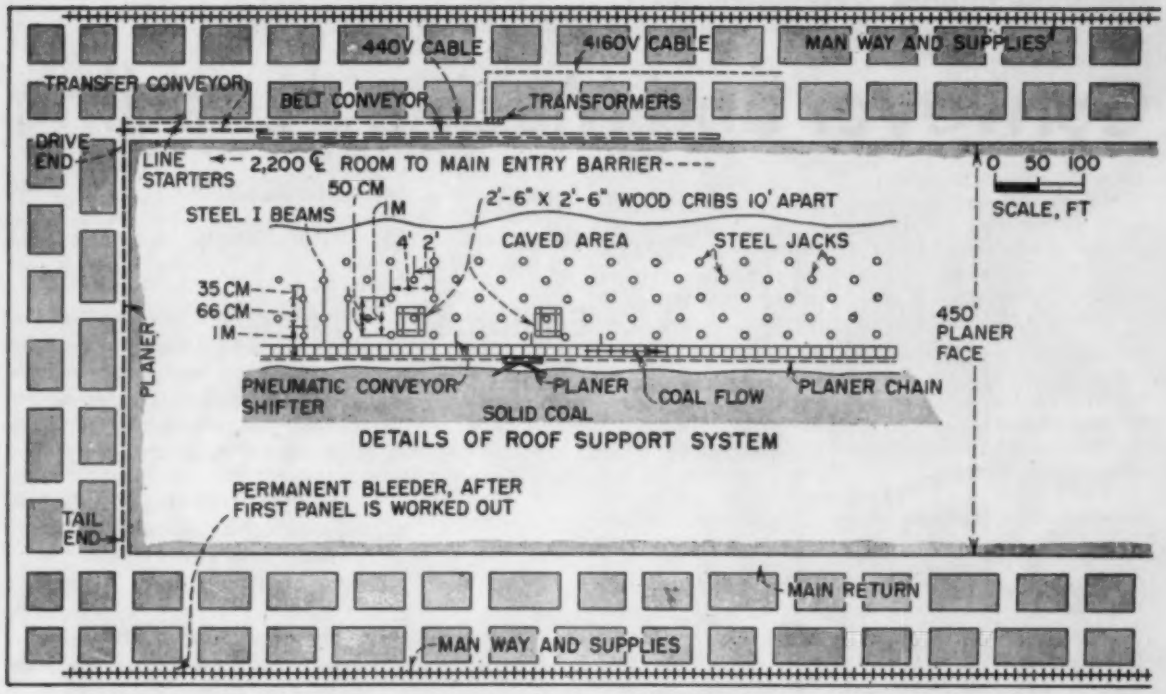
What might be called the conventional pocket-and-wing system (illustration) is with either rectangular pillars or blocks. In one block plan (illustrated) size is 85x85-ft, formed by driving places 15 ft wide with ripper-type miners. Pockets are driven 15 ft wide leaving wings 10 ft thick, which are cut through at intervals to leave small stumps. The roof where this plan is employed is top coal and drawslate, with major support by roof-bolts installed by bolting units on the miners. Once a major break line is established, falls come regularly every 2 or 3 lifts.

Where stumps are left, their size depends on whether it is intended to take them out with the miner, in which case they can be fairly large, or whether it is intended that they crush, meaning that they would be fairly small. Since drilling equipment would normally have to be provided specially on continuous-miner sections, shooting of stumps is a relatively infrequent system, although done in some instances.

Mining pillars on pitches with ripper-type continuous machines has produced pocketing plans very similar to those employed in flat coal. In one instance (see accomanying plan), coal pitch is 17 deg maximum. Rooms are 18 ft wide on 45-ft centers. To recover the pillars a slanting chute, or pocket, is driven across the top end, with crossbars at the mouth to protect the operator while the machine reaches through. The machine then cuts through the wing in semicircular fashion. If possible, the stumps then are taken. If not, they are shot to insure the necessary roof break.

Pocket-and-fender plans include the one for rigid-head machines in thick coal and fair to good roof as shown, entries and rooms are on 90 deg and final pillar recovery in rooms is on an angle. Rooms also are driven in pairs, with thin pillars between the individual rooms and thick pillars between pairs of rooms. These thick pillars are mined by driving successive pockets across the ends, leaving fenders 4 to 5 ft thick. The final operation consists of mining out the centers of the fenders as the machine pulls back out of the pockets.

Top Benching—Coal over, say, 9 to 10 ft in thickness has always presented a problem in pillaring, whether loading was done by hand, by loading machine, or by continuous miner. All the earlier systems, involving driving rooms and crosscuts on the bottom



COAL-PLANER SETUP in 40-in coal, 450-ft face, collapsible steel jacks, headers and cribs for roof control.

and then working up resulted in trouble and loss of coal, not to mention the extra hazard to personnel.

With the advent of roof-bolting, top-benching with both loaders and continuous miners has become increasingly the practice in thick coal. Development is the same as in the past, except that it is done next to the roof instead of along the bottom. This permits securing the roof by bolts and eliminates the need for long posts and heavy collars, which normally are inadequate for the job. After the rooms and crosscuts are driven in the top, the bottom coal is removed by ramping down in the rooms and also in the open-end or split places in the pillars.

Longwall

Consider for very-thin or moderately pitching seams.

ROOF CONTROL is the heart of longwall mining and requires not only special support systems but also considerable specialized experience, compared to the conventional room-and-pillar system. Also, the usual type of equipment designed for room-and-pillar and properly operated gives such a good account of itself that longwall finds it difficult to compete in the thicker, flat seams.

For these and other reasons, longwall in the United States and Canada is so far limited to thin or pitching coal, as a rule. Also it is largely limited to special types of equipment, such as, the stripper or planer, or special ripper equipment operating open-ended.

An example of a longwall face designed for planer mining is shown in an accompanying illustration (*Coal Age*, May 1956, p 72). Face length is 450 ft and average production per shift in 40-in coal is 500 tons, with the maximum 1,000 tons. The aim in roof control is to cave the top behind while keeping the face open with collapsible steel jacks, headers and cribs.

A face designed for a ripper-type longwall unit undel heavy cover in Canada (*Coal Age*, December, 1953, p 84) is operated with packwalls. The walls are established up and down the pitch and the miners operate on pitches up to 18 deg. Length of a wall is approximately 500 ft, or no more than a machine can clean up in a shift. This is necessary because conditions are such that all supplementary work —advancement of conveyor, packwalls and face support—must be done on the offshift, and failure to complete the cut would mean losing a day in the production cycle. On light pitches the machines cut both ways. On heavier pitches, it cuts downhill only and is trammed back to the top of the wall on the offshift.

Originally, the miner discharged to a belt conveyor alongside. "Python"-type flexible chain conveyors are being substituted for the belts, and are pulled over by the miner itself as it returns to the top of the wall in the heavier pitches, thus releasing a conveyor-moving crew of 8 men for other productive work. An incidental benefit is an increase in wall production by eliminating the spillage encountered with belts. On longer walls, this runs to 30 to 40 tons per shift.

Theoretically, longwall provides the maximum in continuity of production, but roof control normally requires more support and more labor to install it, in addition to other special requirements and facilities. Thus, as noted, it finds it difficult to compete with conventional equipment in thick, flat coal. However, particularly where thinness or pitch prevent the use of conventional equipment, the continuity of production with longwall methods and modern longwall units normally—though not always—more than offsets the cost of extra support and facilities, with resultant significant increase in tons per man. Thus, one planer in 3-ft coal has raised output per man-shift to the parting 2 to 4 tons compared to production with conventional methods, while the ripper-type pitch unit has gone over 600 tons in a mining shift with tons per man to the car-loading station, loading shift only, of over 50. Average mining height is approximately 4½ ft.

Conveyor and Machine Loading

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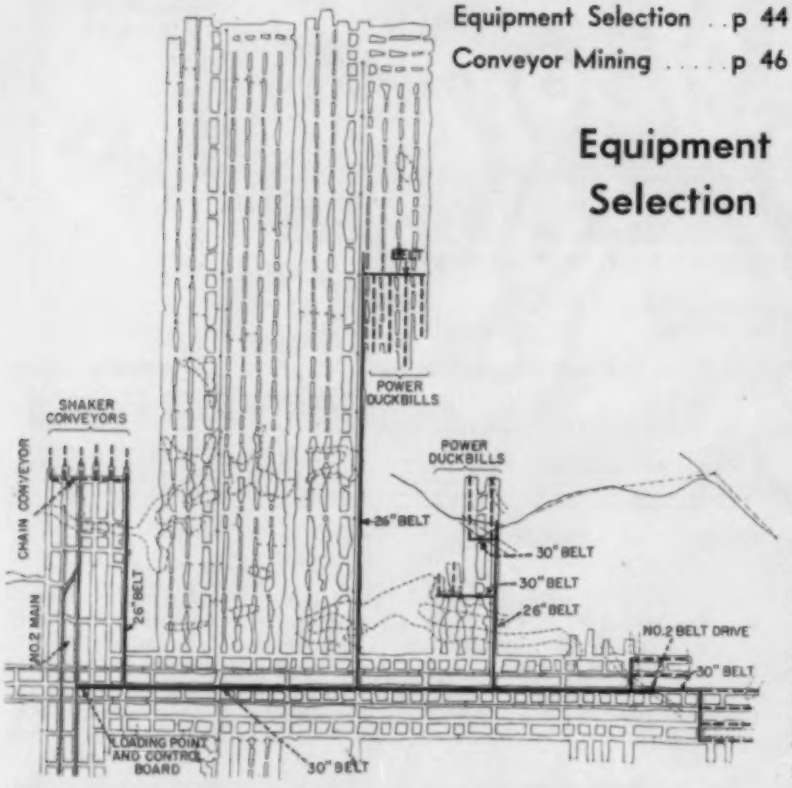
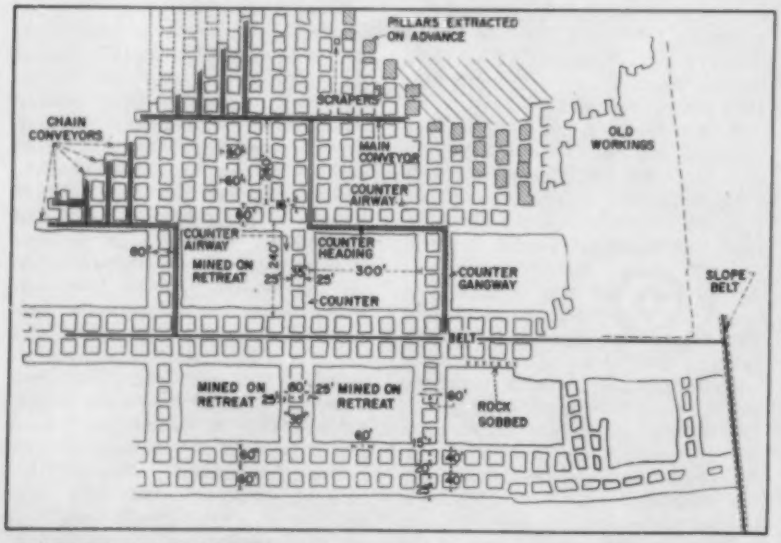
Conveyor Mining . . . . . p 46
Machine Mining . . . . . p 49
Pitch Mining . . . . . p 53

Equipment Selection



"CONTINUOUS-ROOM" PLAN for conveyor mining permits moving room units straight ahead a minimum distance by using mother and cross belts.



CASCADE DEVELOPMENT up the pitch with two groups of conveyors plus scrapers for recovering pillars. Chutes and lowering conveyors bring the coal down to the main belt in the crosspitch gangway.

THIN COAL—New loading machines are being designed to get down into fairly thin coal and should be used where possible. If loaders are not feasible, use self-loading conveyors, other things being equal.

THICK COAL—Use the highest-capacity loading machines and transportation units available, other things being equal.

PITCHING COAL—Use conventional conveyor or mobile equipment up to 8 to 10 deg, conveyors up to 18 to 20 deg, sheet iron up to around 30 deg and longhole drills on the steeper pitches.

ALTHOUGH THE CONTINUOUS MINER will take over more and more of the production load under ground the majority of the tonnage will come from conventional units for a number of years ahead. One reason is that present mobile units have limitations, such as inability to handle hard, heavy partings or get down into the thinnest seams being mined, although answers to these problems undoubtedly will be found as time goes on. In addition, until sufficient continuous machines are built to take the load, it will have to be handled with conventional units.

With the variety of conventional units available today, it is only under exceptional conditions that the choice is limited and only one or two possible types can be installed. One exception — for the moment — is flat or mildly pitching seams under 30 in. Even here, there is still some choice of self-loading equipment, including the scraper and the duckbill or sawbill. Hand-loaded equipment includes the hoist-operated, scraper-type hauler and the various forms of room conveyors—chain and shaker principally.

The equipment noted in the preceding paragraph also may be used in the thicker coal, and is fairly common up to 4 ft, but the development

10 Keys to Mining Success . . .

WHATEVER THE SYSTEM OF MINING OR EQUIPMENT EMPLOYED the overriding goal should be keeping the face units producing at capacity as close to 100% of available working time as possible. To achieve this goal, coal should be available all the time, the machine should be in shape to work without stoppages, and means of getting the coal away should be continuously available. The job involves all echelons of operating management down to the section boss, as well as engineers and other staff men. With this as the key, the job of running a section—or a mine—takes in the following:

1. Establishing Production Standards. Assuming a machine has a rated capacity of 8 tpm and available working time is 400 min, it should produce 3,200 tons per shift. Actually it doesn't—and for good reasons. But what should it produce: 500 tons? 800? 1,000? There is a proper figure, which can be arrived at by the application of industrial-engineering principles. This means studying the operation piece by piece with a watch and a record sheet to determine not only where delays and inefficiency occur, but also how much time normally should be required to perform each operation, such as "Tram to next place." When finally compiled, this information makes possible the setting of a production standard which represents a fair day's work for a fair day's pay. Normally, by making manpower more effective through better distribution of work and a better balance in the production cycle, this means a higher output than otherwise would have been attained. Savings of up to 30% in total mine cost have been reported through establishment of production standards in this fashion.

2. Synchronized Operation. Some of the benefits of balance in the cycle have been noted in the preceding paragraph. Balance also must exist in equipment capacities if over-all balance is to be secured. A cutter or a drill, for example, which is unable to keep up with the loader reduces over-all unit output while the wage bill remains the same, thus running up the cost. The synchronization phase of balanced operation becomes particularly important in conveyor places.

3. Performance Records. The need for records will vary with the responsibilities of the supervisor, manager or staff man, but whatever the degree of responsibility, daily, weekly and monthly records should be detailed enough so that the man can compare present with past performance in his own section and department, and also with other sections and departments. Delay records are almost as important as production records, since they provide the basis on which concrete steps can be taken to avoid a recurrence.

4. Trained Men. This does not mean only formal courses or schooling, though those that have installed such courses report that they are well worth their cost. But even without formal indoctrination, the alert supervisor can fairly well determine practices that contribute to low cost and safety and those that do not. Following that, he is in a position to pass this information along and work for its acceptance. Real down-to-earth training results, for example, when the cost of reconditioning a bent cutter bar is presented to an operator along with some suggestions on how to prevent a repetition. Training, too, takes place when a supervisor and a loader operator work out a scheme for attacking a fresh cut and loading it out with a minimum of moves and position changes thus shortening over-all loading time.

5. Rated Voltage. Not only does voltage less than the nameplate rating slow down equipment, particularly DC—it also breeds a don't-care attitude among crew members and burns out armatures, coils and so on, increasing maintenance cost and upping section cost. Good voltage at the working face should be a primary concern of all operating, electrical and maintenance officials.

6. Expert Machine Care. Low cost today depends on keeping machines running as much of the time as possible at rated capacity. Stoppages resulting from machine breakdown cost as much as idle time from any other cause. Skilled preventive attention is the answer, meaning that a good repairman should never be too far away even if not actually stationed in the section. His main job, however, is inspecting and checking to catch trouble before it starts or make repairs while they take only a few minutes rather than the lengthy periods required for major breakdowns. It helps, too, when foremen and operators have some degree of familiarity with machine design and preventive maintenance methods, including good lubrication.

7. Supplies When Needed. Small breakdowns can have severe consequences when it is necessary to send outside or to some other distant point for a part that should have been in the section stores. The moral is to make sure that the supply items of the right type are at the right place at the time they are needed. This includes even mine props, roof bolts, rail, ties and anything else the lack of which might slow down or stop production.

8. Transportation When Needed. "Continuous" transportation is provided by conveyors, but depending upon the type of production and haulage facilities, shuttle cars and rail cars can provide the equivalent of continuity under most circumstances. The need for "continuity" also applies to mainline haulage, which should be set up to have an empty trip at each transfer or loading station before the previous trip is loaded out. Also, transfer of coal to cars should take place without delaying the shuttle car or conveyor, meaning that facilities should be provided for shifting cars while the coal flow continues, unless, for example, shuttle-car and mine-car capacities are identical.

9. Competitive Spirit. Pride in achievement is a powerful stimulus to excellence in results, whether in production or in baseball. A "beer bust" is one form of reward for a record-breaking job, but incentives do not have to be tangible to achieve results. Merely pointing out the crew standing, with praise if at the top or with pointed reminder if down the list, usually can stimulate the competitive spirit to a substantial degree, with consequent salutary effect on production and cost.

10. Safety Always. Last but by no means least in any set of principles for running a mine or a section is constant emphasis on safety. Aside from everything else, injuries cost in increased compensation and medical payments, in lost output, and very frequently in damage to mine and equipment. Even where no injury results, a roof fall, for example, can tie up machines and involve anywhere from a minor to a major removal and cleanup expense.

MOBILE DRIVE SECTION reduces conveyor moving time by making it possible to tram it to the next room for quick setup schedule.

Trend Markers—Conveyor and Machine Loading

Hand-loaded and self-loading conveyors being more and more limited to very-thin coal or special conditions. Retreat on both sides of a panel the most-common conveyor plan.

Standard line of loading machines for normal thicknesses of coal being expanded by units with capacities up to 15 tpm for very thick coal, and by thin-vein units for coal as low as 28 or 30 in. Increase in the availability of thin-vein units altering significantly the basic production picture in such veins.

Bridge conveyors growing as a means of insuring high productivity through continuous haulage, especially in the thinner seams. Otherwise, shuttle cars get the call.

Block plans with bleeder openings becoming more popular. "Flat" or low-angle pillar lines finding greater application.

Longholing continuing to gain as a means of mining heavily pitching coal.

Case Finders—Conveyor and Machine Loading

Loading in 26-in Seam—Thin-seam loaders coupled with bridge conveyors and 13½-in high rope belts promote efficiency. Specially designed low-slung compressors and supply cars are key units. Full retreat mining the rule in panels with pairs of rooms drive both ways. *Coal Age*, April, 1957, p 60.

Loading in 5-ft Seam—12-man crews with crawler loaders load to shuttle cars tramming to panel belts. Both AC and DC employed. *Coal Age*, June, 1957, p 74.

of on- and off-track loading units, which offer the advantages of flexibility and high capacity, along with ease of moving, has resulted in their taking over to a considerable extent in coal thicker than 3 to 3½ ft. Off-track haulage equipment normally accompanies off-track mining equipment, though it is being challenged by the extensible belt, the bridge conveyor and other new conveying developments providing very close to continuous haulage. Such units also can cope with very soft bottom which, in the past, has resulted in a few instances of adoption of track haulage even when rubber-tired haulage units were available.

Pitch Equipment

Conventional conveyor and mobile equipment can be used with a high degree of efficiency up to approximately 18 to 20 deg. At 10 deg or less there is only a slight difference in results, if any. Where haulage is concerned, the breaking point where conveyors usually must be substituted for rail cars or shuttle cars usually is around 5 deg. However, rubber-tired equipment has been used in cross-pitch rooms or chambers to around 12 deg. The maximum pitch on which mobile machines may be employed is yet to be determined though up to 18 to 20 deg has been achieved.

Explosives and gravity remain the major production tools where greater than sheet iron pitches are encountered. To make it possible to bring these forces into play with a minimum of labor, major emphasis is being placed on the development of the longhole drill.

Conveyor Mining

Concentrate conveyors into groups of two and preferably four or more.

Drive up first and mine rooms and pillars on the retreat. An acceptable alternative under most conditions is advance on one side while driving the entry and retreat on the other.

Schedule operations at the face so that loading is carried on with a minimum of interruptions for cutting, drilling, shooting, timbering and so on.

Select mining plans that cut moving time. Try to buy or redesign all types of conveyors to facilitate moving and save time. Use pullers or carriers—home-grown or purchased—to ease the moving job.

CONVEYORS TODAY normally are used in groups of two to four, although the variations are almost infinite. The benefits of grouping are those usual with concentration. Single conveyors are found mostly in pitching coal, and in second or third mining of anthracite. And whether single or multiple, in rooms or in entries, conveyors usually discharge either to a panel belt or to a gathering or cross conveyor concentrating the output at a single car-loading point.

Chain conveyors of the conventional type require a drive for any change in direction. However, the "snaking" or "python" conveyor used abroad are designed to permit a certain amount and sometimes con-

siderable bending in service. As a rule they are much heavier, however, than the commonly used U. S. types. It is possible to bend standard chain units slightly, though it is not recommended because of increased wear. Thus, when hand loading onto chain units, it is necessary to keep place width down to practical shoveling distance unless face conveyors are used. With face units, rooms can be driven 50 ft, 60 ft or more in width where roof and other conditions are favorable. Wider faces ease the problem of arranging the cycle so that loading proceeds with minimum interference and maximum efficiency. And even though the face conveyor is longer, putting it on wheels or rollers and designing the joints for quick breaking and making (*Coal Age* October, 1952, p 77, for an example) permits rapid moving even where close timbering is necessary.

With shaker conveyors, swivels make it possible to swing the face end rather readily, provided jacks and posts do not interfere. Thus, within limits it is possible to widen the place without going to face units or turning the trough. At the same time it is possible to keep the face end of the conveyor in the most favorable position for hand loading. Ability to use swivels and turns permits driving crosscuts and working pillar places without separate drives. Bellcranks also permit operating separate trough lines from the main unit as desired. Uphill types with curved discharge chutes also can lift coal or rock and load it into cars without auxiliaries.

Adding a duckbill or sawbill makes the shaker conveyor self-loading. Power swing and power advance and retract also are available on duckbills. Compared to loading by hand, adding a duckbill, sawbill or power duckbill increases the number of cuts that can be mined in a shift by from one to three, thus, in some instances, as much as doubling the output per shift.

Cutting Moving Time

One of the biggest headaches in the use of conveyors of the conventional type is not only extension time but also moving time. Though there are not too many, some methods for saving in moving time do exist. As previously noted, equipping face conveyors with rollers is one. Couplings that are quick to lock and unlock, and special tools for breaking and joining chains are some.

The time-consuming and costly job of moving from one place to another can be materially eased by at least certain steps, including the following:

1. Turning the moving job over to special crews.

2. Using pullers and carriers to eliminate most of the physical effort and much of the time involved in shifts from one place to another. Shortwell trucks of the crawler or rubber-tired types can be used for carrying or towing or both. Or pullers and carries specially designed for the job, including the necessary winches, may be purchased or made.

3. Using mobile drive sections. These mobile sections, mounted on crawlers, have made it possible to move an entire room unit completely in as little as 1½ hr.

Certain mining systems help in cutting down on charges for moving conveyor parts and such materials as crossbars and the like. If only one place is worked at a time, as an example, blind cross cuts may be driven toward the next place, and pans, chain and materials may be stored in them for pickup as the new place comes up to the crosscuts. Or, the conveyor line may be left intact in the old place to permit pans to be taken off as needed and moved through the crosscuts.

Special mining plans designed to reduce moving time include the "continuous-room" setup shown in an accompanying illustration. One place, it will be noted, serves as a beltway, with a cross unit bringing the coal over from the others. When the "rooms" have advanced the set distance, another cross unit is installed after the drives for the room conveyors have been moved up. Moves thus are made straight ahead and over a minimum of distance, reducing the time requirements.

"Panning up," or conveyor extension, when done section by section, interrupts face operations and requires both time and labor. The bridge conveyor is one method of reducing the number of interruptions and the time required. In fact, the first bridge unit was developed to reproduce pan-up time in hand loading, but was quickly adapted to carrying coal away from loaders and continuous miners because of its manifest advantages.

Conveyor Plans

The plans adopted for conveyor mining are as numerous as the variations in equipment units, but the most-used ones are two:

1. Driving the room entry up the full distance and then working rooms on one or both sides on the retreat. If the mining is done on both sides of the panel, one equipment unit may alternate, or matching units may be used on both sides, as in the plan shown on p 49. Though this plan involves auger-head mining the conveyor layout is typical of those used with hand or machine loading.

Where the coal pitches and entries or gangways are driven on the strike, places are turned up the pitch.

Occasionally, as demonstrated in the accompanying illustration, a subopening may be established up the pitch to permit two or more groups to be operated in cascade fashion. A variation is driving stubs up the pitch, equipping them with proper lowering equipment, then turning rooms across the pitch starting at the top of the stub and working down.

2. Developing the room entry and at the same time working rooms on one side of the advance, then completing the panel by retreat on the opposite side, is another common conveyor system. This normally results in a more even output rate over the life of the section, and also keeps all working sections on the fresh-air side of the panel ventilating system. In driving and advancing on one side, the entry, as shown in the accompanying plan, may be advanced a certain distance and then the equipment moved into the rooms to mine them out, after which another entry advance is made.

In any system, most operators like to prepare room necks in advance. Thus, if the entry is completely developed in advance, places may be necked 2 to 3 cuts on one or both sides to be ready for final mining —that is, with a two-heading entry. However, if chain-pillar crosscuts are made on room centers necking may be unnecessary on one side. And with a three-heading entry, with the belt in the center, crosscutting on room centers can eliminate any necking on either side, though many operators still feel that it is worth driving in to the point where room widening starts. Also crosscutting on such short centers may be undesirable from several standpoints, including extra stoppings and more likelihood of roof trouble.

Pillar Extraction—Where the coal is under 3 or 3½ ft and the top permits, many operators prefer to reduce pillars to a minimum and leave them, some arguing that the value of the coal left is less than the cost of the timber that would have to be put in to recover it. In at least one instance part of the pillar is pocketed out and the remainder left to protect the next pocket, eventually crushing with subsidence of the top. Where pillars are taken, usual prac-

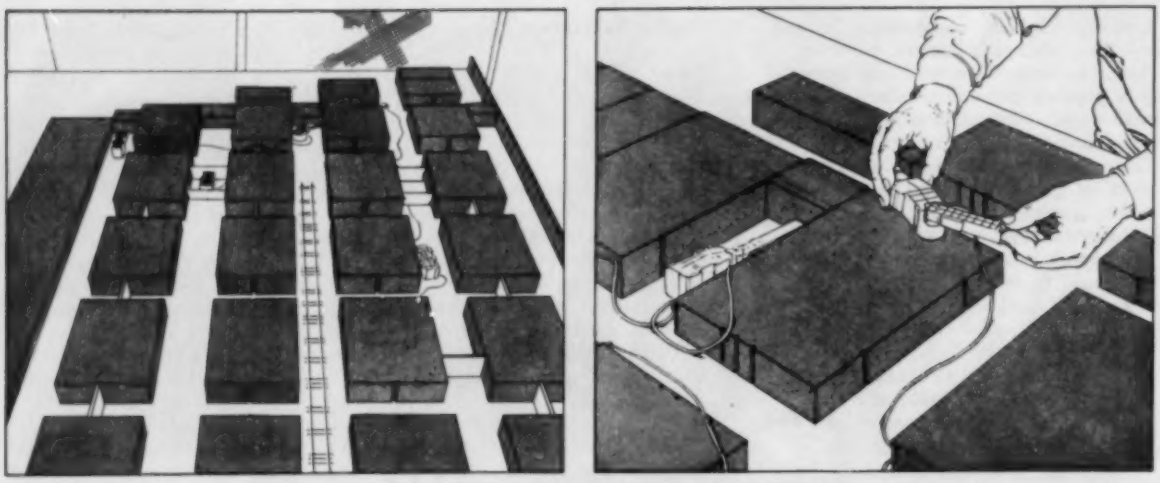
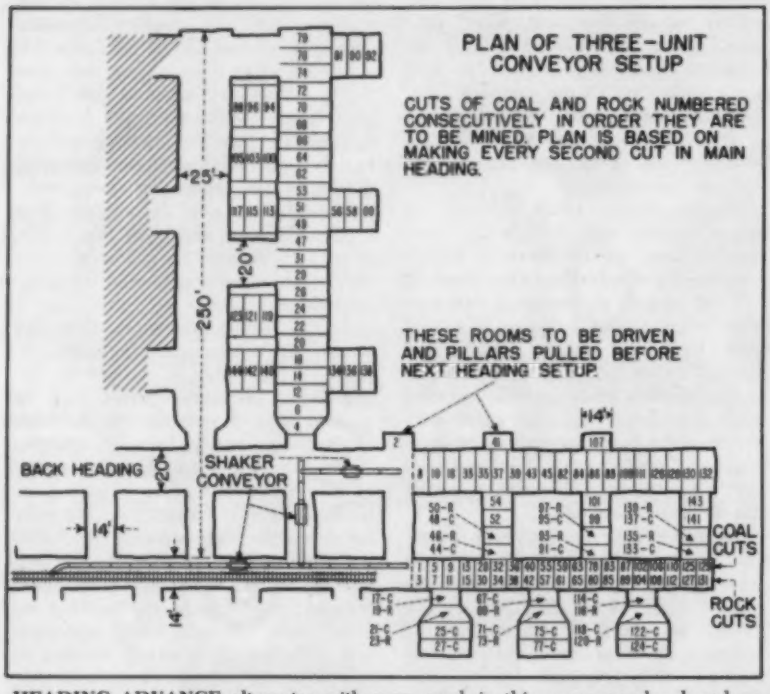


TABLE-TOP MINE MODEL provides an opportunity to solve problems quickly and easily, saving time and money in trial and experimentation.


PLAN OF THREE-UNIT CONVEYOR SETUP
CUTS OF COAL AND ROCK NUMBERED CONSECUTIVELY IN ORDER THEY ARE TO BE MINED. PLAN IS BASED ON MAKING EVERY SECOND CUT IN MAIN HEADING.
THESE ROOMS TO BE DRIVEN AND PILLARS PULLED BEFORE NEXT HEADING SETUP.
25'
20'
250'
20'
BACK HEADING
SHAKER CONVEYOR
14'
14'
COAL CUTS
ROCK CUTS

HEADING ADVANCE alternates with room work in this conveyor plan based on mining on one side on the advance and on the retreat. Rock is loaded every second cut in haulage headings, where necks are made extra deep.

tice is to widen to one side only, putting the conveyor along the straight rib where it is close to the pillars to be removed.

Unit Organization

In addition to the room and—possibly—face and cross conveyors and elevators, the usual practice in setting up a conveyor unit is to put a shortwall cutter and a drill in each place. Attempts to move cutters from place to place make it difficult to set up a tight face cycle, which is essential for maximum efficiency. Drills may be separate, each with its own cable, though a common practice is to plug drills into cutting-machine takeoffs.

Flexible-shaft drills, likewise operating from cutter takeoffs, have made major strides in conveyor and other mining in recent years, as has the hydraulic hand-held drill powered either from the hydraulic system on the cutter or, if the cutter has no hydraulic facilities, from a special hydraulic portable pump.

Other equipment frequently found in a conveyor setup includes specially designed rockdusters and bolting units. Supply-handling equipment includes wheeled dollies operating in pan lines, and small hand or powered winches to pull timber and other heavy materials up to the face.

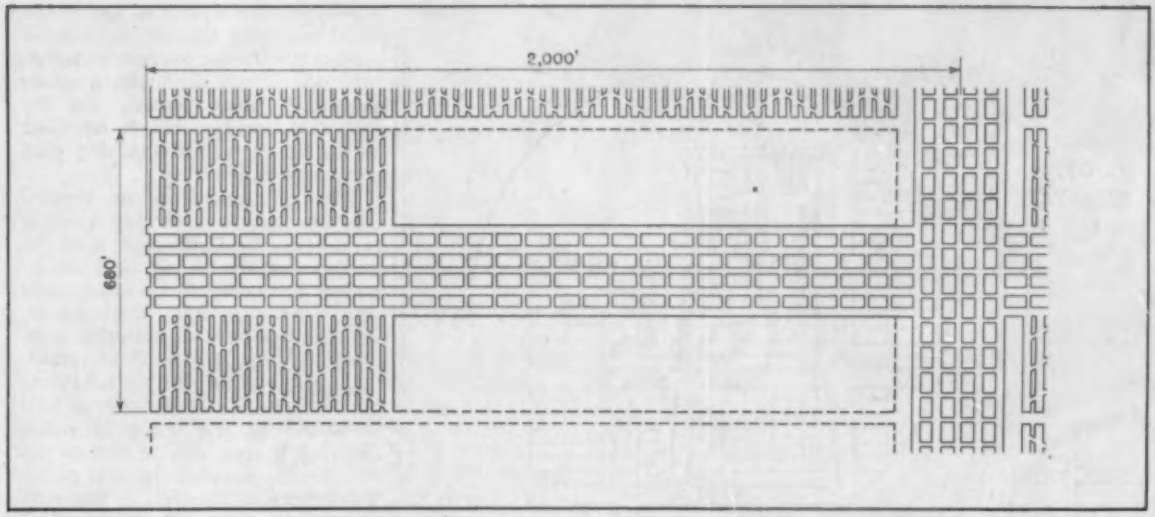
The false pan line is a simple and effective alternative in flat or mildly pitching coal. Until the halfway point of the place is reached, a false line is built alongside the regular line by pulling it forward and attaching a section each time the regular conveyor is extended. Each new false pan is loaded with enough supplies to take care of that much advance of the face, and the line is pulled up by the cutter so that the inby pan can be unloaded and added to the regular line. When the last section of the false line is pulled up, the room is completed.

Outby the rooms, supplies may be brought in by rail trucks, by rubber-tired equipment or by reversing the panel belt. Some belts have been fitted with jogging and inching controls for this purpose (*Coal Age*, April 1946, p 86).

Scheduling Face Work

The usual face crew, whether loading by hand or power, is 3 or 4 men, with as high as 10 to 12 on extra long faces. Average output, in hand loading, is 1 to 3 cuts in the usual rooms. With self-loading equipment, production is increased to 2 to 4 cuts per shift—sometimes more.

Attaining production rates of this magnitude requires a careful study of crew size and operating cycle. Unless places are extra-wide or some special situation exists, the usual face



KEY-ROOM PLAN with shuttle-car haulage in thin coal. The center heading of the panel entry is brushed for track and mine cars. Rooms are worked in groups of five to seven, and the crosscuts are angled from the key room for easy shuttle-car travel.

crew, as noted is 3 to 4 men. More than that number under normal conditions seems to result in interference and lost time.

The cycle itself is the critical factor in high productivity. For high efficiency, the various elements in the cycle—cutting, drilling, shooting, etc.—must overlap, and must be tightly scheduled to prevent waste motion and time loss. The basic goal is as little interruption in the flow of coal as possible. The best way of attaining it is through time study and the establishment of a fairly rigid system of standard times, plus a fairly exact schedule of when to do what.

Machine Mining

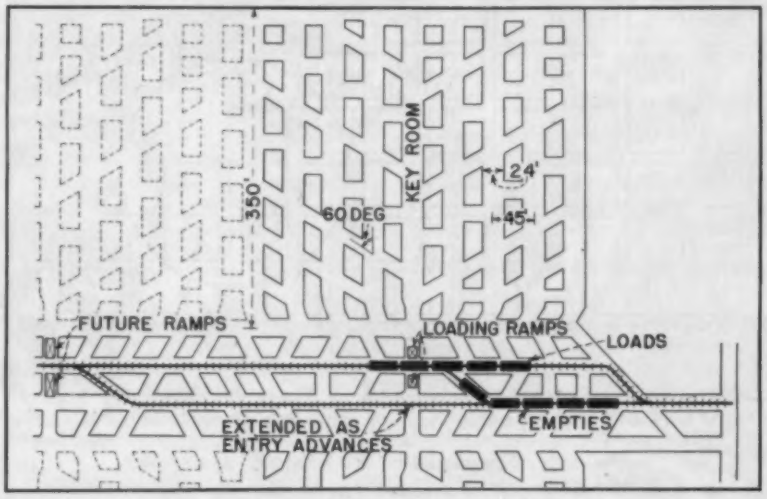
Take pillars to increase recovery and cut development cost. Consider the advantages of the flat pillar line.

Provide enough places so that coal is always available.

Keep haulage distances short. Consider the possibilities of bridge and extensible conveyors.

THE BASIC machine-mining unit, meaning here the unit based on a mobile loading machine, is made up of the loader itself, a cutter, a drill and, in most instances, one or two shuttle cars. Additional equipment may include a roof-bolting unit, a rock-dusting machine and a mobile supply truck.

A high degree of flexibility characterizes this unit, and thus it has been applied in practically all types of mining including semilongwall, in both thick and thin coal and in both



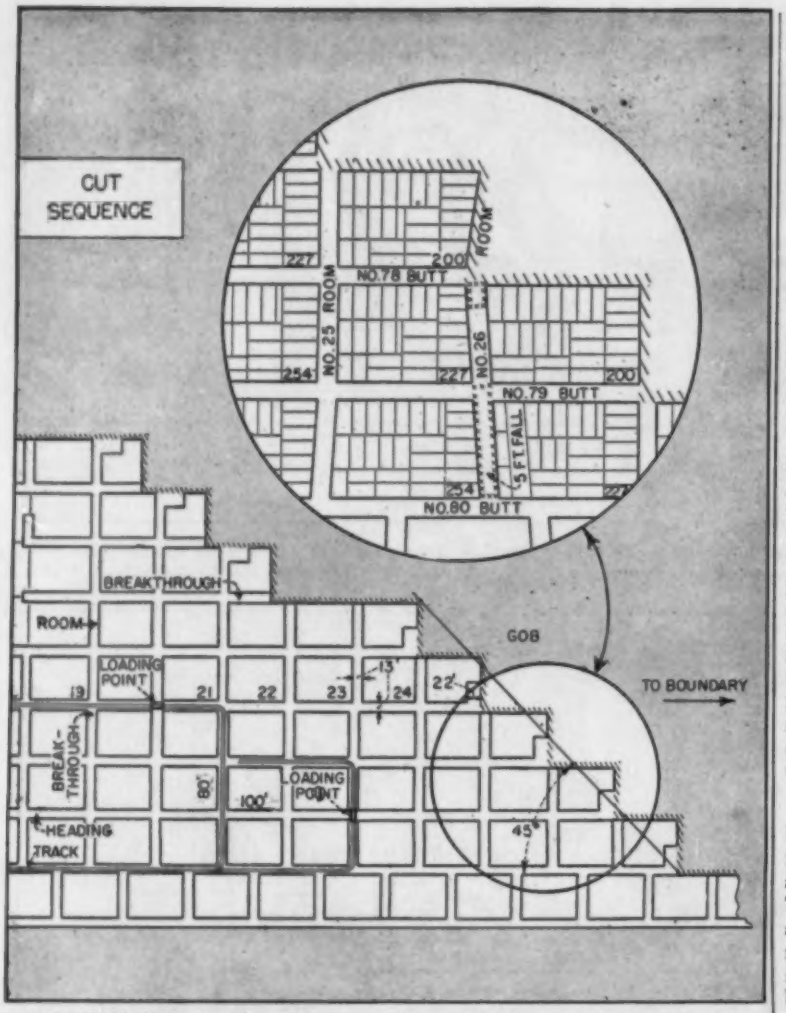
SHUTTLE-CAR PLAN showing double-tracking for mine-car loading, key rooms to loading ramps and angle crosscuts for faster shuttle-car travel.

flat and lightly pitching seams. Number of working places per unit ranges from a low of two up to 20 or more. The average is 6 to 10. Crews range from 3 to 5 up to 20 to 25 men, with the most common around 8 to 12. Production per unit runs from as low as 100 tons up to as high as 1,500 tons per shift, with 300 to 600 tons as the majority. Tons per faceman ranges from 20 to nearly 100 in a few instances, with 30 to 50 perhaps the most common.

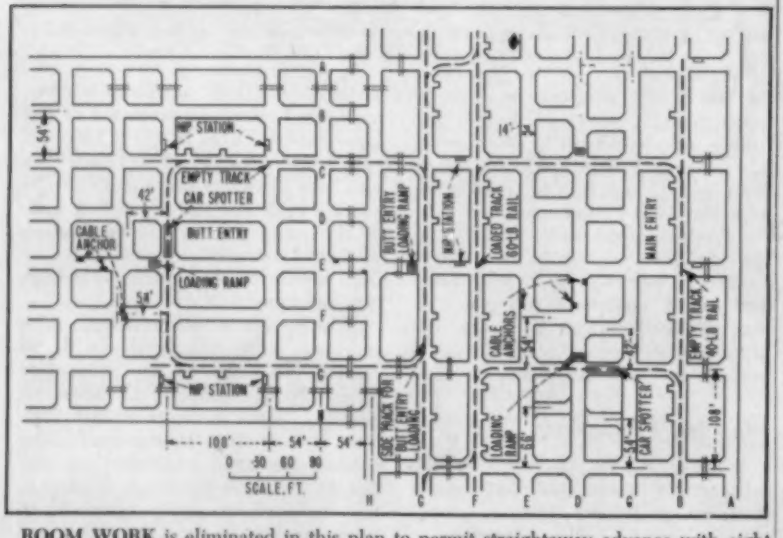
Machine Projections

Because of the flexibility of the loading unit previously noted, mining plans range from completely closed panels with no pillar extraction to what might be termed the wide-open system with all openings—entries, rooms and crosscuts—projected on the same centers. This latter, if followed completely, results in dividing the coal into blocks of uniform size, permitting both flexibility in attack and, at the same time, a standardization of extraction methods conducive to both high unit productivity and high tons per man.

Where pillars are removed with machine units, the tendency is to reduce the angle of the pillar line from 45 deg—sometimes down to zero, or to a completely flat line. Two major advantages result. One is that the span supported on the projecting points or stumps is materially reduced in going from 45 to some smaller angle. On a flat line the span vanishes. And as the span



LOOP CIRCUITS simplify rail haulage and keep cars right-end-to in this block plan for shuttle cars. Pillars are open-ended in numbered sequence to provide close control of breakline. New places are developed only as necessary.



ROOM WORK is eliminated in this plan to permit straightaway advance with eight headings and mining of entry pillars.

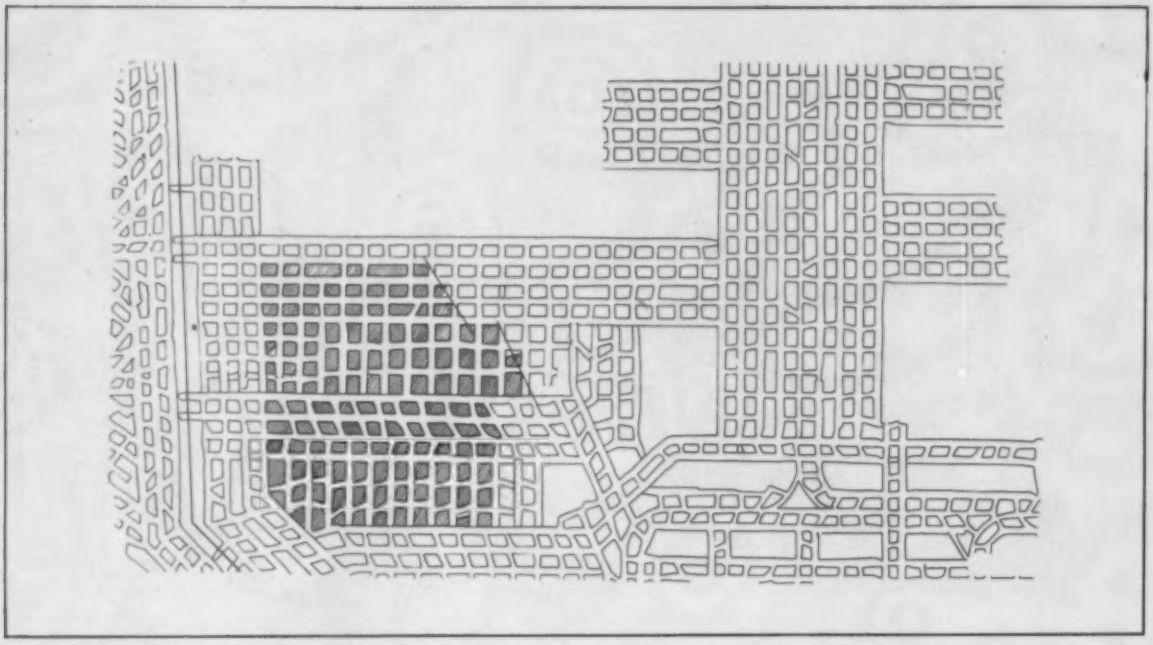
is reduced, the weight of top in the angle requiring support is reduced accordingly. In one instance a change from 45 to 22½ deg, with a minor change in block centers, cut the weight to be supported to one-third of the total under the 45-deg plan previously employed.

Whether short lines or stepped lines are feasible is another question in projection. Each case must be studied individually but there are instances of successful operation with very short lines. Also, there are instances of steps of considerable magnitude in lines as a result of permitting entry recovery to lag behind to provide room for a tail track, as well as permitting one group of rooms operated by one mining unit to get considerably ahead of the next group. The conclusion therefore is that with most top there is considerable flexibility in establishing and operating pillar lines, though, other things being equal, a reasonably long straight line normally provides the maximum results with a minimum of trouble. And whatever the system, a cardinal rule is getting the coal out clean or making sure that any pillars or stumps that cannot be recovered are shot before they are left.

Planning With Models—To reach better answers to questions as what methods are best, at least one operating company uses table-top models. The elements in table-top modeling are blocks of the correct size to represent pillars; cardboard or other sheets to represent stoppings and brattice lines; wire or cord for cables, etc., plus miniatures to scale of the machines. When a problem, such as where to anchor shuttle-car cables, comes up, it can be solved by setting up a typical working section and experimenting to find the best spot. Cuts of coal can be added or subtracted by using small blocks and an entire pillar-recovery cycle can be run through as examples of other things that can be done.

The overall look afforded by the table-top model makes it easier to see all the elements of a problem and thus frequently points to the obvious solution immediately, saving time spent underground and on experiments that do not work out according to an article in *Haulageways*, a publication of the Ohio Brass Co.

Preventing Bumps—In brief and perhaps oversimplified terms, bumps are the result of a concentration of stress in the interior of a block or blocks of coal as a result of weight. As the weight builds up, the coal in the pillar is stressed more and more,



BLEEDER OPENINGS in this retreat plan are formed by leaving pillars along one side of the panel entry.

until it suddenly fails in explosive or semiexplosive fashion.

Preventing weight buildup is a combination of a number of things as outlined in a more detailed discussion of bump prevention in the section on "Roof Control," p 60 Careful study will permit evolving a mining plan which will eliminate or reduce load buildup of the type which results in bumps.

In addition to mine layout, pillar design and pillaring system, bumps may be avoided by drilling or augering suspected pillars. In this process, the weight is unloaded gradually, or the bump is triggered while the weight concentration is small and before actual mining of the pillar starts. For a fuller description of the pioneer drilling and augering plan for bump control, see *Coal Age*, January, 1955, p 68.

Machine Plans

A key factor in efficient machine loading is coal and transportation at all times. An adequate coal supply requires, among other things, an adequate number of places in which to work. The basic rule is that as soon as the machine is finished in one place coal should be ready in the next for loading. Acceptance of this rule means that with conventional room haulage—usually the shuttle car—the minimum number of places usually is four, exclusive of crosscuts. In the past, however, some operators have approached the question from the standpoint of high tons per man from a small crew in two to three places. If tons per man are high enough, they compensate for the fact that fewer tons are secured per dollar of investment in machines. New equipment, on the other hand, removes this objection to a small number of working places. The bridge conveyor is an example, but even with it there should be enough places so that the loader never has to wait for coal.

Shuttle-Car Haulage—Though there are many variations, the section layouts for shuttle-car haulage tend to be one or the other of two types:

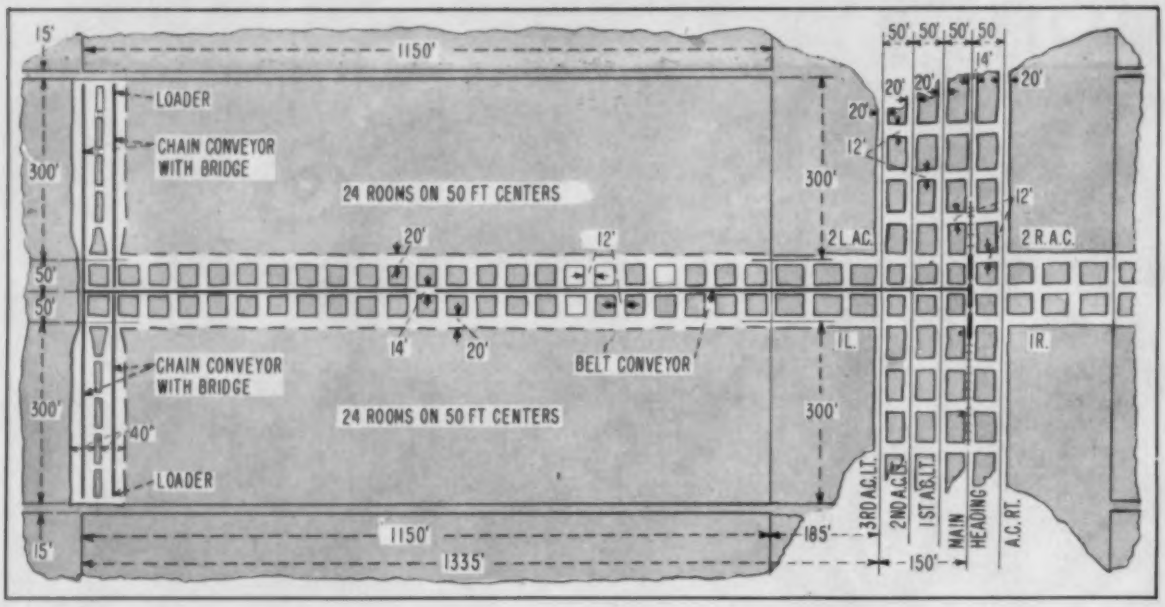
1. The panel plan with rooms turned both ways and driven in groups of 5 to 7 or more. One reason for the use of this plan is the fact that pillars are not recovered. However, with modifications, pillaring can be done with this plan also.

2. The conventional block or room-and-pillar plan devised for pillar mining, either with short lines for each room section or longer lines advancing continuously from section to section. To facilitate the latter, some block plans, as noted elsewhere in this section, are set up with all openings on the same centers so that pillar lines can be established and advanced without having to shift gears when an entry is crossed.

In developing for both plans, the usual practice is to drive a minimum of 4 or 5 headings to make entry work as near like room work as feasible and thus as efficient as possible. Heading stations are established every 200 to 300 ft, at which distances the shuttle-car haul is kept under the generally accepted maximum of 500 to 550 ft. If track is used, it may be looped completely, or may be turned into a room or back down the next heading to establish a tail track for transfer from shuttle car to rail car.

Crosscuts may be angled each way from the center heading to facilitate higher-speed shuttle-car operation. This is especially true in operations based on mining individual panels, and particularly where pillars are left. In some plans, the angle crosscuts continue to become rooms, with angling continued in making room crosscuts. In a group of five or more rooms, for example, the center usually becomes the key room, often leading directly to the car or belt-loading station. An example is shown in the accompanying plan, 34-in coal, center heading brushed for track haulage. The rooms are driven in groups of 5 or seven, depending upon conditions and equipment. A second plan for thick coal shows double-tracking of the panel entry for faster trip handling. Mining in this instance is done on the advance.

Three other plans accompanying this section show right-angle development for pillaring. Depending upon the particular setups, they also show loop track and bleeder openings, the



THIN-COAL PLAN is based on using bridge conveyors behind loaders in pairs of places on each side of panel entry.

latter in one instance being formed by leaving the pillars on one side of the panel entry.

With track setups, all shuttle cars normally must dump at the same point. Consequently one must occasionally wait on the other. Where panel belts are used instead of track, however, some operators restrict one shuttle car to dumping at the end and require the other to use a crosscut farther down to prevent interference and loss of time in waiting to use the same dumping point.

Extra-thick coal offers some special problems in machine mining. At one mine, as an example, though the mining system went through a number of changes, all openings invariably were driven along the bottom. Top and rib deterioration and the onset of weight always outpaced the rate of extraction, thereby making it difficult to achieve the desired recovery. The cure was found in driving the openings in the top of the seam and bolting the roof, which permitted fast, economical removal of the lower portion of the pillars by loader or scraper (*Coal Age*, November, 1954, p 92).

Track Haulage—In loading directly into mine cars, maximum efficiency involves these steps:

1. As big a mine car as possible to reduce the number of changes per cut.

2. A one-way distance back to the closest changing point of not over 150 ft.

Prefabricated track provides a reliable means of attaining the second objective, as well as the further goal of track that can be installed, taken up and moved quickly and with a minimum of labor. Prefabricated track also forces adherence to the mining plan, which is helpful over both the short and long pulls.

Conveyor Haulage – Being a continuously operating haulage unit, the conveyor was early seized upon for service behind loading machines. The difficulty of keeping the machine discharge over the conveyor, with consequent loss of time by the operator, added to the time and cost of moving the conveyors, resulted in, first, a trend to mine cars and, next, to shuttle cars. New types of units, however, are putting the conveyor back into the loading-machine picture. One example is the bridge conveyor, which is connected directly to the loader to provide a continuous conveying line. Another is the extensible belt.

Bridge-conveyor plans normally are based on two or three places per unit. Basic equipment in the unit is two or three room conveyors, two or three bridge conveyors, a cutter and drill in each place, and a crawler-mounted loader, plus mother or cross conveyor, elevator, car-spotting hoist, roof-bolter, rock-duster and so on. The loader moves from place to place, and a mounted cutter may be substituted for the individual shortwalls, alternating with the loader. In general a good top or one which lends itself to bolting facilitates the use of bridge conveyors by making it easy to establish the necessary travelways.

Operation is much the same whether rooms or entries are being driven. An entry-driving setup is shown on p 50 of this issue. Average performance in 34-in coal is 20 to 25 tons per faceman. One element in this performance is a tight well-balanced cycle, involving four men approximately 30 min in preparation and two men 30 min in loading, as follows: (1) two men drill two shot holes; (2) two men sump cutter; (3) one man continues to cut while helper and third man drill three remaining shot holes; (4) one of the latter two loads, tamps and prepares to shoot while the other sets permanent timbers to replace safety jacks; (5) fourth man installs conveyor pan and cleans up loose coal; (6) face is shot; (7) loader crew of two men loads out the cut. Note that preparation and loading require identical times, meaning no lost time for the loading machine. Steps to achieve this goal include bugdusters on cutting machines, 8½- and 9-ft cutter bars, and crawler trucks and three-wheeled push carts for handling equipment and supplies, plus loop track to reduce car-change time.

A panel setup for bridge conveyors is shown in an accompanying illustration. Coal thickness is 26 to 36 in. The mining plan (*Coal Age*, April, 1957, p 60) is full retreat with pairs of rooms turned right and left off the panel entry. Panel haulage is by belt. Average output is 21 to 22 tons per faceman. A pair of rooms is completed in about five days. The conveyor lines are left in place and the mobile

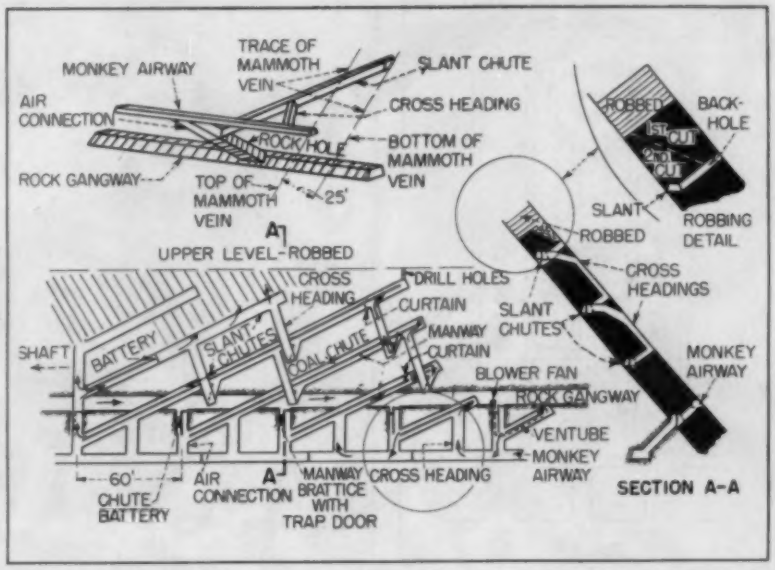
drive sections are trammed to the new sites with enough pans and the tail section to start the new rooms. Equipment moves take about 5 hr and are made on the third shift by six men from the regular crew.

Pillaring Plans

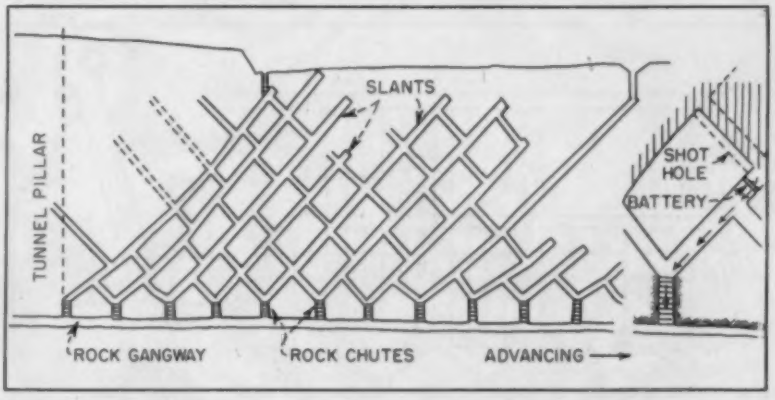
Loading machines can be used in practically any system of mining individual room pillars, including slabbing and splitting. The two most-used plans, however, are open-ending and pocket-and-stump. Examples of these and other plans are shown in the "Continuous Mining" section of this Deep Mining Guidebook.

A variation of open-ending is pocket-and-fender, under which the stump is cut down to a shell only 2 to 3 ft thick. A subvariation is gripping the cutting machine out each time to make a saw-toothed fender and increase recovery slightly. Timbering plans for pillar mining are discussed in the "Roof Support" section.

In open-ending, it usually is best to arrange the direction of advance so that the machine operator is on the side away from the coal and protected from sloughing and rib bursts, particularly when heavy weight is the rule and the coal is soft.



SLANT-CHUTE SYSTEMS (above and below) are examples of plans devised to reduce manual labor and raise efficiency in steep-pitch mining. In line with general practice today, gangways are driven in rock under coal.



Pitch Mining

Use self-loading conveyors or scrapers, standard loading machines or continuous miners on light pitches. The latter normally provides highest tons per man where conditions permit use.

Use longhole methods in heavy pitch; as an alternative, use a slant-chute system. Consider the possibilities of induced caving. Bore cross-cuts to save labor and cut stoppings cost.

PITCH MINING may be defined as mining on grades greater than those that can be negotiated readily by mine cars or shuttle cars, or around 5 to 6 deg. The maximum on which crawler-mounted equipment can be moved without too much difficulty is around 15 deg. Light-pitch mining may therefore be defined as mining between 5 and 15 deg. Heavy-pitch may be defined as the degree of pitch at which the coal will run on the bottom. This normally is something over 35 to 40 deg.

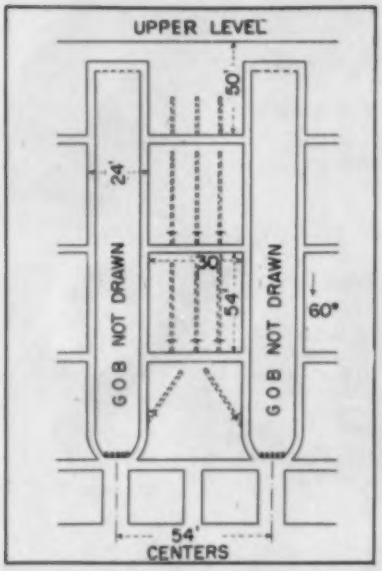
Light Pitch

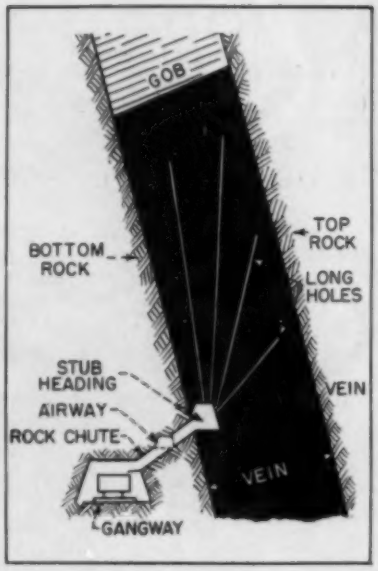
Practically any type of equipment may be used at the face of places driven either up or down light pitches. Normally, however, some form of conveyor is necessary for transportation. With this limitation, all the ordinary panel plans, with or without pillaring, and practically all the conventional face equipment may, as noted, be employed. Usually, particularly as the pitch increases, the practice is to put headings up, down or both—usually up—and rooms across the pitch. Among other things, this permits the use of shuttle cars on pitches up to 10 to 12 deg or perhaps slightly more, the cars discharging to either a lowering or hoisting conveyor relaying the coal to the main-haulage system. Angle crosscuts between places permit easier movement of units from place to place in conventional machine loading.

Moderate Pitch

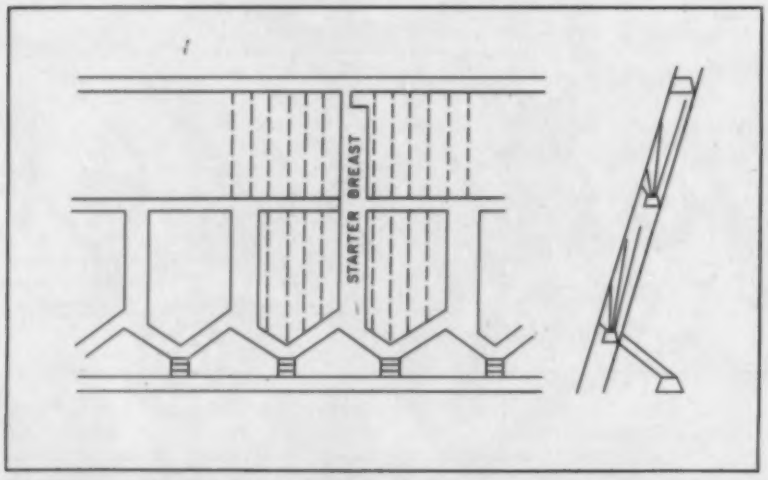
Galvanized iron kept wet provides perhaps the flattest gradient on which coal will flow of its own accord. The minimum is around 20 deg. At about 25 deg, coal will begin to flow on ordinary iron and, at something around 35 deg, on wood. Below approximately 20 to 22 deg, therefore, it normally is necessary to install conveyors to move coal down the pitch.

Where pitches of this degree prevail, customary practice is to sink belt or rope slopes, turn gangways right or left on a grade rising slightly to facilitate water flow, and then work rooms up the pitch, using hand labor to get the coal to the conveyor or chute. Modifications, however, include a few plans for crosspitch room work. One involves driving a pair of rooms up a 40-deg pitch and installing in one a timber track with hoist, a ladder and a chute. Rooms are turned 90 deg across the pitch, and a shaker is installed along the lower rib of each one, with a second





TWO LONGHOLE PLANS show (left) development along usual lines except that pillar size is increased to permit drilling and shooting, and (right) operating in nearly vertical vein with only drill headings in the coal.



LONGHOLE DEVELOPMENT PLANS include this version employing sub-breasts at intervals plus counters for removal of the coal in two lifts.

pan line along the upper rib which serves to bring in supplies.

Heavy Pitch

Attempts to eliminate the high percentage of hand labor necessary in steeply pitching seams have been only partly successful, though the introduction of longhole drilling is beginning to alter the picture substantially. It too, however, requires a fair amount of hand labor in driving openings for air and for preparing the sites and faces for longholing, though not as much as previous systems.

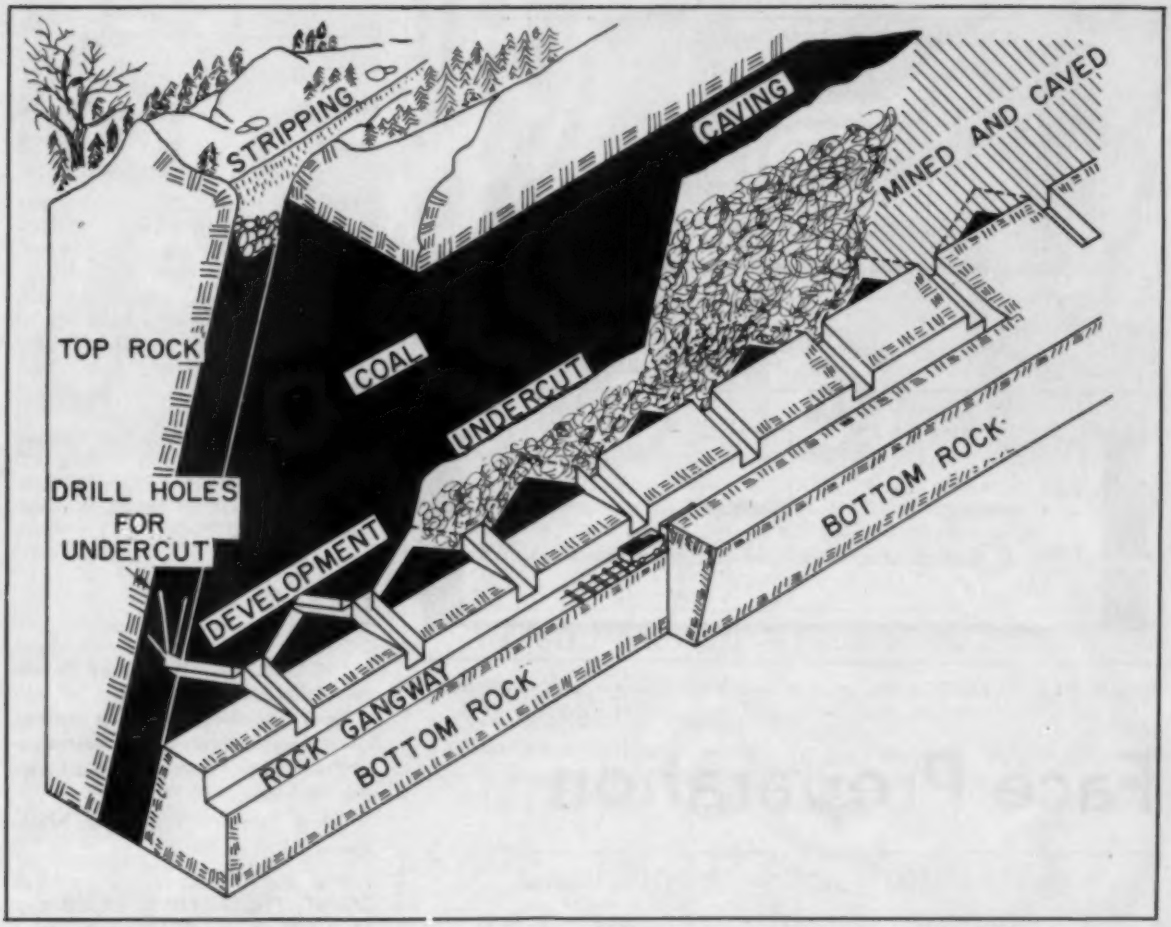
Initial longhole experiments go back over 20 yr in the anthracite region, with a lapse of over a decade after the first trials. Meanwhile, to alleviate the labor and difficulty of advancing breasts straight up heavy pitches, attention was concentrated on plans which would cut down the pitch of openings in which men had to work to that on which coal would run on either iron or the natural rock, meaning to a minimum of 35 to 45 deg. The "lattice," "diamond," "slant-chute" and other similar plans were evolved, differing largely in details—for example, 30-deg openings with sheet iron and without batteries in one "diamond" plan, compared to 45-deg openings, no sheet iron and batteries at intervals in one "slant-chute" system. In both, the openings are first developed to the old gangway above and the pillars are recovered on the retreat back down. Usually, one-third to half of the pillar is drilled with holes up to 45 to 50 ft, loaded with explosive placed with detonating fuse to insure complete detonation, and shot. The coal then flows to cars in the gangway, controlled as necessary by checks or batteries. In the slant-chute system a new battery normally is built immediately below each time a new section of pillar is shot.

Because life usually is long and disturbance in the vein can be substantial after mining gets well started, the trend is toward gangways in the rock under the vein, with rock chutes up to the coal. This leaves a strip of coal between the rock gangway level and the top of the rock holes. This strip may be recovered from the next gangway below, or short, level rockholes can be driven to the vein, which then is opened up by chutes as necessary and then drilled and shot into short conveyors leading back to the rock gangway.

Induced Caving—Another proposal for reducing labor in mining heavily pitching veins is "induced caving." Similar in principle to "block caving" in metal mining, the system has shown promise in its initial trial. The original idea, as developed by the Bureau of Mines, is shown in the accompanying illustration. It involves a gangway in the rock under the vein, rock holes up to the coal, slant chutes between rock holes in the vein, and undercutting of a section of the vein by drilling and shooting to induce caving, with the coal drawn off through the rock chutes as caving progresses up to the surface or the old level, unless rock dilution becomes excessive. Production in the initial experiment was 33.5 to 38.8 tons per man-shift.

Longholing

Variations in longholing methods largely reflect how much preliminary development work is done. As an example, in moderate pitches, the conventional chambers and crosscuts may still be driven, the principal change being an increase in the size of the pillar left. The pillars then are drilled and shot instead of being mined in the ordinary way. Holes therefore are seldom more than 50 ft long. An example of plans where the emphasis is more on drilling of pillars formed along conventional lines is shown in the accompanying illustration along with an example of longholing with a minimum of development.



ORIGINAL INDUCED-CAVING CONCEPT for mining steep anthracite veins involving undercutting after development to start the caving.

Longholing with minimum development at one operation, as an example, is based on gangways and airways in the rock beneath the vein, with rockholes to the vein at intervals fitted with batteries to control coal drawoff. Holes drilled back from the next rockhole and cased with pipe insure positive ventilation behind the battery both before and after shooting. Holes also are drilled to the next level above to drain off any water that may have accumulated.

Longhole drilling is done from a heading in the coal. To start a section, two places are driven up to the old workings and the chain pillars are removed to provide expansion room for the coal to be shot. Then the coal between two rock holes is shot by three groups of three holes each, one parallel to the bottom, one angling up through the vein and one directly toward the top rock. Firing is done on off-shifts or idle days.

Longholing with a little more development in the form of sub-breasts at intervals and counters for drilling the upper block is shown in another illustration. For starting, one breast is developed up to the upper gangway. After the upper block is drilled the lower is removed in similar fashion.

The capital investment required for longhole drilling is relatively small and productivity at the face is increased 50% or more.

Dos and Don'ts – Use close-fitting joints of special scroll-type augers for preventing drift of small holes, and guides at 5- to 10-ft intervals in big holes to maintain direction and prevent whipping of the steel.

Keep cuttings in suspension in wet or damp coal by air through the rods, discharged either through holes in the bit or hollow couplers between auger rods.

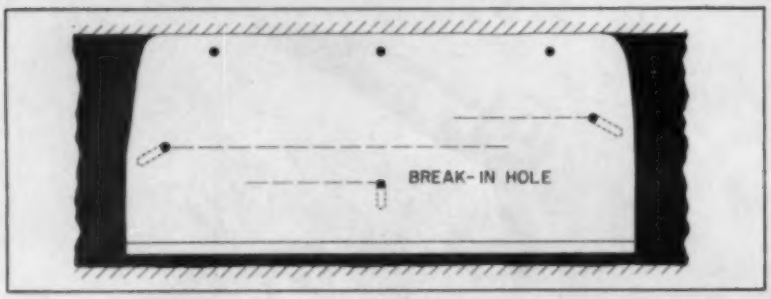
Check to make sure no charges are detonated in gas. Use lock-hook sectional tamping sticks with the hooks made of nonsparking metal—copper or aluminum.

Clean holes thoroughly. Use long-length sticks of explosive to reduce the change of separation of charge.

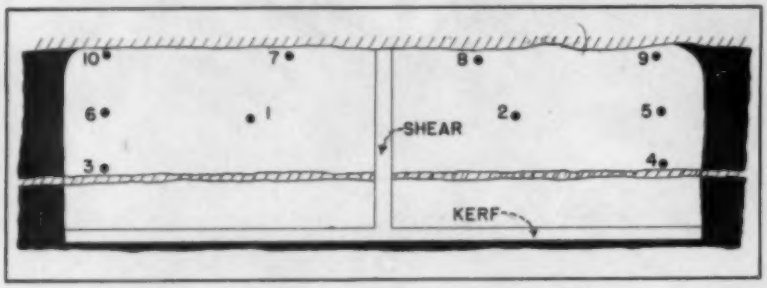
Make sure detonation is complete – by using detonating fuse, as an example—both for greater effectiveness and as a means of eliminating the possibility of burning explosive igniting coal.

Boring Crosscuts

One of the more aggravating and expensive items in gangway development in coal in moderate to heavy pitch mining is crosscutting between gangway and airway. The big drill is one answer. Size may range from 24 to 42 in, and one, two or three holes may be drilled up the pitch to get the required crosscut area. In contrast to an earlier version (*Coal Age*, May, 1951, p 100) a new and much-lighter type (*Coal Age*, August, 1955, p 58) employs a hoist and rope to pull the big bit through a pilot hole. Another advantage of the bored crosscut is that a simple disk rather than an expensive custom-made stopping can be used to close it.

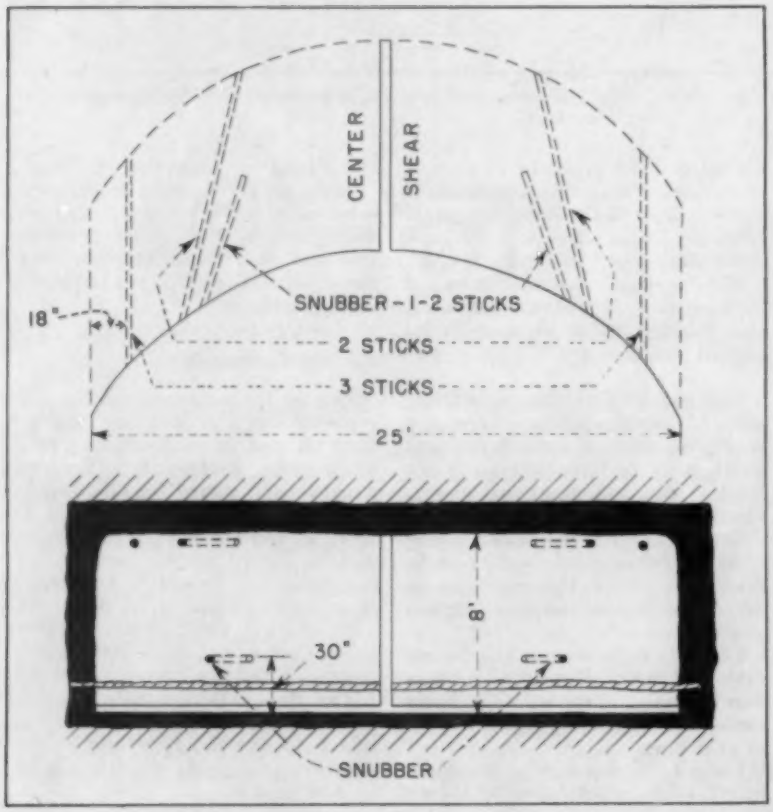


BREAK-IN-HOLE provides additional free face for relieving succeeding holes. In this plan, rib holes are stepped up to break lower part of face in section.



EQUALIZED BURDEN is the goal in this drilling pattern in a center-sheared place, thus achieving good breakage of both coal and impurity band.

Face Preparation



SHORT SNUBBERS break band and roll out front of fall in arc-cut center-sheared place. Shearing and snubbing reduce the number of holes required and also cut explosives requirements to a minimum.

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Drilling ..... p 58
Shooting ..... p 58

FACE PREPARATION has a direct bearing on the efficiency with which the loading operation is conducted. Good falls—loose and well rolled out, but not pulverized and scattered—make it possible to load from one to several more places per shift raising tons per man accordingly. In addition, good face preparation cuts the cost of explosives and promotes safety. The price is nothing more than careful, constant study of cutting, drilling and shooting, including equipment, bits, placement of cut or cuts and placement of holes.

Bits

Use types that cut the most in tons per dollar of cost.

Keep bits sharp for faster cutting, lower power consumption, less wear and tear on the machine, and a better size realization.

Adopt measures to prevent breakage and loss of bits.

BOTH THEIR OWN COST and their effect on productivity, plus, even, their effect on the size consist of the coal, make bits important. Under some conditions, the old carbon bit, forged and quenched, can give a good account of itself. However, these situations are growing fewer, and the need for greater capacity with fewer interruptions for replacement and sharpening has resulted in the development of throwaway, hard-faced and carbide-tipped bits for both cutting and drilling. They sometimes run for days before changing and resharpening are necessary. Some designs can double in brass—for example, drilling first coal and then drawslate where it is taken down for height or for safety; or cutting in either coal or partings if required.

Aside from the desirability of keeping all possible metal out of the coal, insert-type bits cost considerable money in themselves. The rule, there-

PROTECTION against damage or loss is necessary with modern cutting and drilling bits. Left photo shows locked cabinet for preventing loss and mishandling. Cabinet has a compartment for each section's supply. Right photo shows wooden bit holders in lunch boxes carrying section numbers for easy handling.

SAFETY ACCESSORIES include galvanometer to test circuits in millisecond delay shooting—a growing practice for promoting both safety and efficiency.

fore, should be an old bit or a thorough accounting before a new bit is issued. Establishment of fixed quantities in the hands of each cutting, drilling or continuous-miner crew—or at least in each section—supplemented by regular inventories will help keep down losses. Grinding to restore bits to service condition also can materially affect cutting qualities and the total number of regrinds, meaning service life. Manufacturer's recommendations should be the guide. For a step-by-step illustrated description of grinding and reconditioning both cutter and drill bits see (*Coal Age*, July 1957, p 71).

Trend Markers—Face Preparation

Rubber-tired universal machines taking over more and more of the cutting load. Bar length increasing.

Hand-held drill use upped by development of flexible-shaft and hydraulic-powered units.

Millisecond delay shooting increasing.

Case Finder—Face Preparation

Air Breaking—New Type air-breaking tube and central compressor station serves mine in 46-in coal with 2- to 14-in binder. *Coal Age*, July, 1956, p 65.

Cutting

Use long bars, other things being equal, to reduce number of loader moves.

Consider universal machines for greater flexibility in cut positioning and because they make it possible to shear when desirable.

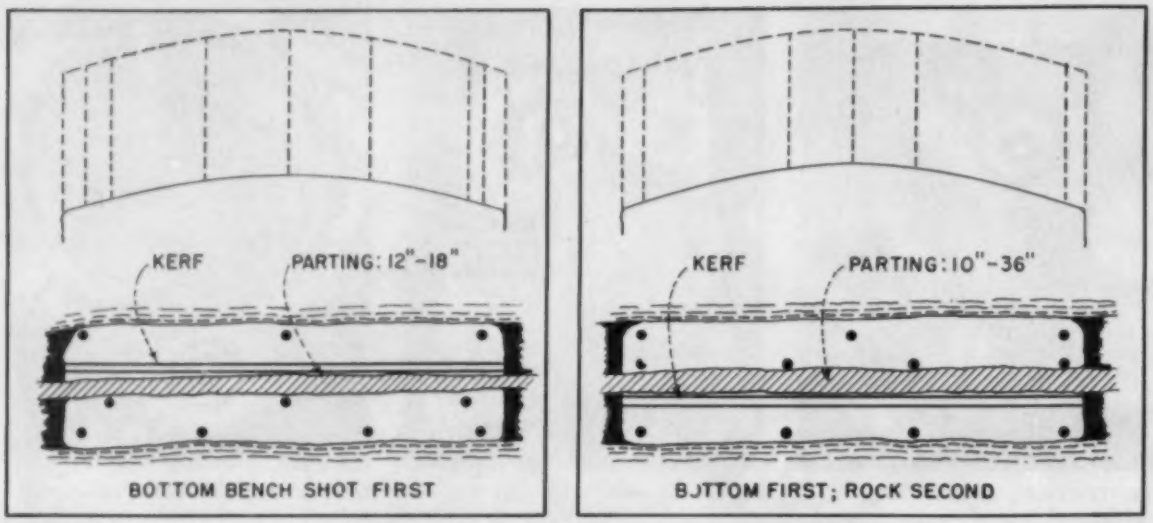
THE SHORTWALL and the rubber-mounted universal machine are the predominant cutter types today, with the latter accounting for more and more of the total tonnage because of flexibility, greater mobility and higher capacity. The shortwall, however, still dominates in conveyor mining, particularly in thin coal, and also is a part of mechanical units in thick coal at a number of mines. Hydraulic tilting makes it easier to use and adds appreciably to capacity where the cycle is tight. Bugdusters can materially reduce labor and normally make it unnecessary to clean the kerf. Otherwise, kerfs should be cleared of cuttings to promote safety in shooting, reduce powder consumption, prevent "hung" cuts and generally improve loadability.

Long bars are a distinct advantage in machine loading, since the more tons per fall the fewer the time-wasting moves the loader has to make. Cutting with a long bar, however, requires greater operator skill and increases the risk of striking undulations in the bottom and top, as well as the risks of fouling and binding. If they replace shorter bars on an existing machine, care should be taken to make sure that the motor can carry the extra load, either as is or with improved insulation.

Cut Positioning

Simplicity, ease and custom are behind the preponderance of undercutting, which has the further slight advantage that the fall helps to break up the coal. However, it normally necessitates shooting against the top and thus, where this results in serious deterioration, has led to top cutting. Cutting at other horizons may be done to get into softer zones, but usually is adopted to remove bone or rash. Where the latter is the goal, two or three cuts may be taken—or one regular cut may provide enough loosening and relief so that most of the remaining material can be raked out.

Cutting under a middle parting in thicker coal may be done as one step in bench mining, the lower bench being shot up and loaded, followed by dropping and disposing of the parting, and shooting and loading of the top bench. Very infrequently, cutting may be done in rash or soft clay under the seam, or in soft material above, either to keep the kerf out of the coal or to eliminate hazardous or troublesome top material.



SHOOTING WITH HEAVY PARTINGS. Plan at left shows cutting above the parting, followed by shooting of the bottom bench first. Plan at right, for still-thicker parting, shows cutting underneath the rock and holes immediately above.

However, such selective mining is on the decrease and the trend today is toward full-seam extraction, including, in some instances, top stone or draw-slate. This system relies on mechanical cleaning on the surface for removal of the impurities, since it normally results in a lower over-all cost.

Special goals in cutting include raising the undercut where the bottom is soft, to provide a good coal pavement for the operation of shuttle cars and other equipment.

Shearing

The vertical cut, or shear, provides an additional free face, or faces, and is highly valued by many operators as a means of reducing explosive consumption, raising coarse-coal yield and increasing loadability, even though it does result in more bugdust. In permanent headings, some operators have sheared both ribs to keep them free from shooting shock and thus postpone and reduce falls and sloughing.

Since shearing takes time and, as noted, increases the output of cuttings, shear cuts normally are limited to one—usually at the side in headings or other narrow openings, and between one-third over and the center in rooms.

Drilling

Match drill to the job; choose auxiliaries, such as augers, on the basis of performance.

DEPENDING upon conditions and personal preference, operators have a wide choice in drilling equipment, including not only pneumatic equipment but also hand-held, post-mounted and mobile units. The latter may be designed with one or two arms, with hydraulic auger drive now coming to the front for greater capacity and flexibility. Hydraulic drill-positioning frequently can release one man from the crew for other productive work.

Hand-held units driven either by flexible shafts or hydraulic motors are a relatively recent addition to the types of drilling machines available and in some instances have successfully challenged even large mounted units. Light weight, high speed and operation from the cutting machine through either a mechanical or hydraulic takeoff are among the secrets of the machines' success. Where the cutters do not have a hydraulic system, certain operators have found the drill benefits sufficiently large to warrant installation of a special portable hydraulic power unit.

Augers—The "conveyor" auger or approximations thereof now has taken over to a considerable extent from the old twisted auger in coal drilling. Advantages include greater rigidity, with consequently less whip, and more resistance to bending. These features are especially valuable with hand-held flexible-shaft or hydraulic drills, where whipping or a bent auger is especially noticeable. Better hole cleaning also is an advantage, particularly where large holes are necessary.

Shooting

Choose breaking medium carefully to fit conditions and give the size consist desired.

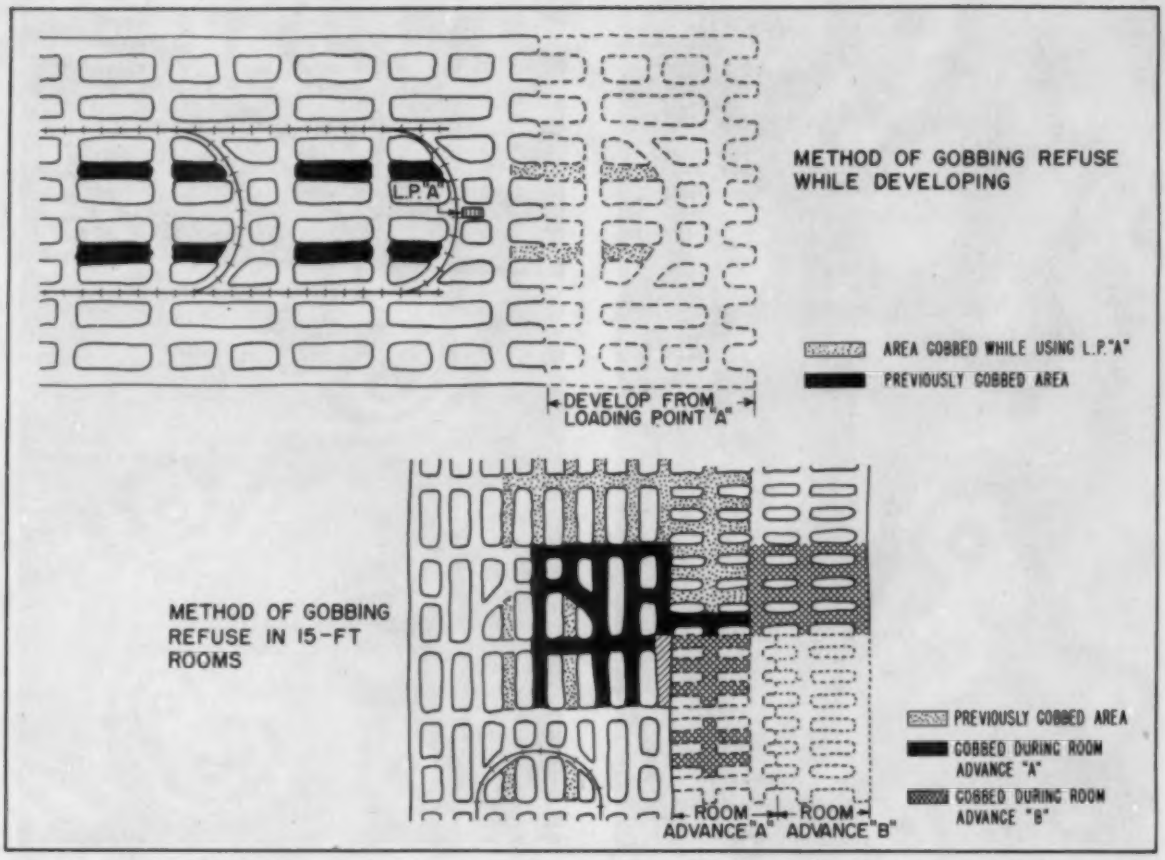
Study the job carefully to get the best hole pattern.

Stem carefully.

A WIDE RANGE of explosives and several breaking devices are available for the operator's choice in coal breaking. The breaking devices include carbon-dioxide, air and chemicals, all basically relying on building up pressure in a tube against a disk which ruptures at a certain limit to release the gas or air and break the coal. Air is the most-used non-explosive breaking medium, and the practice for some time has been to supply it from central stations on the surface, sometimes supplemented by large portable or semiportable units underground at strategic points throughout the mine.

As a rule, carbon-dioxide, air and chemical breaking require a greater number of holes because the maximum force is less, though some operators get by with no increase and many with only a small rise in number. Any increase or other extra expense normally is more than offset by an increase in coarse-coal yield, or by other benefits, including ability to break coal on shift where all other shooting or breaking is forbidden by law or regulation.

To get the effect of a slower action with powder, some form of "cushion shooting" may be employed if other conditions are favorable. The air


METHOD OF GOBBING REFUSE WHILE DEVELOPING
L.P."A"
AREA GOBBED WHILE USING L.P."A"
PREVIOUSLY GOBBED AREA
DEVELOP FROM LOADING POINT "A"
METHOD OF GOBBING REFUSE IN 15-FT ROOMS
PREVIOUSLY GOBBED AREA
GOBBED DURING ROOM ADVANCE "A"
GOBBED DURING ROOM ADVANCE "B"
ROOM ADVANCE "A"
ROOM ADVANCE "B"

TWO GOBBING SYSTEMS used where heavy partings are cut out to reduce the need for hauling the material outside and disposing of it on the surface. One system is used in heading advancement and the other in room work.

space around the charge may be secured by increasing the size of the hole or by placing the charge or stemming to leave an air space ahead or behind. Caution must be exercised to see that cartridges are not separated, thus setting up conditions favoring possible misfires.

Hole Placement

Shooting patterns are almost as numerous as coal mines. Normally, the best pattern for any mine can be determined only by careful study and considerable experimentation. One basic principle is that each hole should "relieve" the next. A second is that the burden on each hole should be adjusted to the maximum charge that can be loaded, though this maximum does not have to be the legal maximum. Consequently a common pattern is a row of holes in the top in thin coal, or in the top and middle in thicker coal, with the center hole shot first in the bottom row in two-row faces, and in the top row in one-row faces.

Modifications are numerous. One, as an example, is a row of holes immediately over a slate parting low in the seam to smash it and relieve the regular holes. Another is the snub shot, which may be a full-length hole in or close to the center to knock down the lower part of the cut and open up the face for the subsequent holes. As a variation, the snub hole may be drilled only part way in to break down and roll out the front of the cut. Bottom and snubbing holes may be angled down to get better breakage at the back and more force to kick the coal to the front.

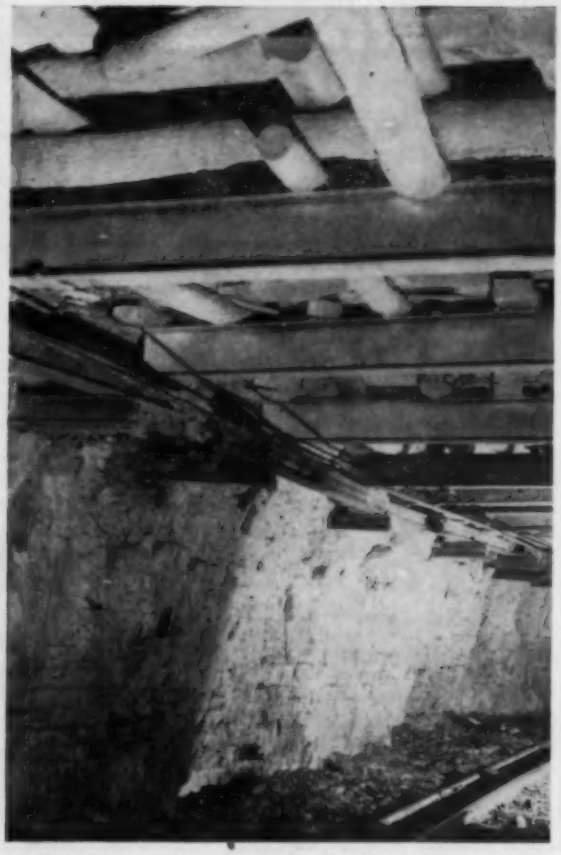
Concentration may be sought for or avoided. As an example, the benefits of drilling a smaller hole may be more than offset by the stringing out resulting from use of smaller cartridges, thus preventing sufficient concentration of force to break the coal properly and economically. On the other hand, concentrating the force at the back of a deep cut in thin coal may result in the charge breaking down to the kerf in the back and leaving the front standing. One remedy is a slower-acting medium strung out over more of the hole.

Charging and Firing

Stemming always is used with conventional explosives, but normally not with steel-tube blasting devices. However, instead of stemming, safety regulations in some regions require setting safety barriers or deflectors against each hole or the entire face to eliminate flying tubes. In lieu of conventional stemming, blasting plugs may be employed with explosives to save time.

Single-shot firing with electric detonators still is the predominant system in the coal mines. However, it has definite disadvantages, one of which is the fact that the shotfirer is constantly exposed to the hazards of loose roof and must work in considerable smoke and dust in connecting to each charge after the first. As a result, there has been a substantial increase in millisecond delay ignition of shots in sequence. There is equal safety in relation to gas and dust, less chance of overbreaking exposing charges, less shock to the roof, and much less exposure hazard for the shotfirer.

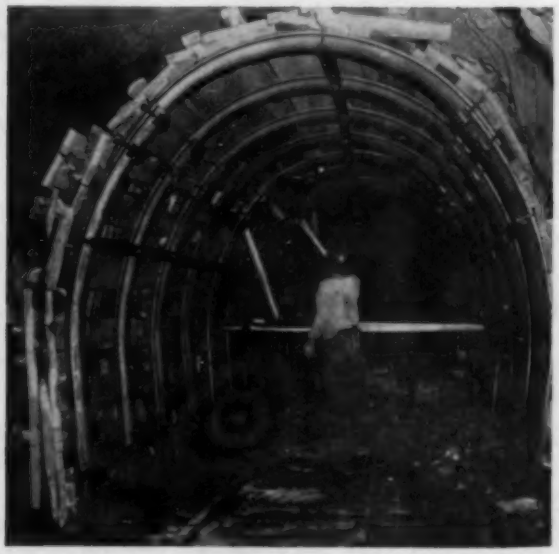
THREE-PIECE SET is the old-reliable in permanent support with timbers. Treatment materially lengthens life.



HITCH TIMBERING eliminates legs. Lagging and cribbing protect top in this pin-and-stringer version.

Permanent Support—Four Basic Systems

STEEL LINING protects opening in soft ground. Other linings include concrete and sand-cement.



YIELDING ARCH for unstable ground can be made of steel, as in this installation, or of concrete sections.

Roof Control

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Roof-Bolting ..... p 67
Continuous-Miner Plans ..... p 71
Coating and Sealing ..... p 71

AS OPENINGS ARE MADE in coal removal, the equilibrium of stresses is upset. The unsupported weight of the top results in a tendency to sag. This sagging continues until failures occur unless (a) support is provided to prevent such failure or (b) the strength of the rock is such that it can support itself after the sag reaches a certain point.

In addition to the possibility of complete loss of the working place, removal of the coal also involves the possibility of falls of loose material. Roof support therefore is required in coal mining for two reasons:

1. Protecting men—and facilities—from falls, crushes, bumps and other top, face and rib failures.

2. Keeping working places, including entries, open for the desired length of time, which may range from only hours in pocketing through a pillar with a continuous miner up to as much as 50 yr or more for entries and airways in especially long-lived properties.

Achievement of these two primary goals also means achievement of certain collateral objectives, including:

1. No interruption of haulage, travel and other operations. Obviously, a heavy fall on the main line can shut down a mine completely, aside from the cost of cleaning up and timbering or retimbering. Even with light falls there is a penalty which, if falls occur with some frequency, can total a considerable sum in the course of a year.

2. No blocking or partial blocking of service openings, such as, airways and drainways.

3. The achieving of these goals at minimum cost. Support cost is such in many mines that even a slight change in the direction of economy can save several cents per ton.

Roof Action

Know and understand the various types of roof action as the best approach to the problem of efficient, economical support.

SUPPORT varies with the objective, and also with the character of the material over the coal. For example, temporary protection against drawslate will require one type of support, while another type will be more suitable where both the drawslate and all the overlying material must be held. Still others will be better suited to permanent openings in bad top or caved ground. Weathering as a result of changes in temperature and moisture content of the venilating air may warrant sealing the top, which is "support" in another guise.

In no instance, however, is it contemplated that the support provided by the original coal bed be replaced by support that will keep the roof in its original place and state after all the coal to be mined is removed. Even "permanent" support means only support until mining is completed. Between the time the coal is first opened up and the final pillars are removed, therefore, a number of roof conditions and roof actions may be encountered—some at every mine and all at some mines. Among them are:

SAFETY POSTS OR JACKS at the face and posts or posts and bars behind them were the original and still used supports.

Temporary Support—Posts and Bolts

ROOF-BOLTING now provides temporary and permanent support for over half the bituminous coal production.

1. Falls of Immediate Top—These result, among other reasons, because the top material is inherently weak, such as, drawslate or clod; because of cracks and cleavage planes; because of the presence of kettlebottoms, slips and the like; because of weathering; and as a result of such mining operations as pillaring. Such falls constitute the majority of the "accidental" type, and are the ones causing most of the injuries and fatalities, most of the operating interruption, and most of the cleanup expense.

During 1956 the typical falling rock was 13 ft long, 11 ft wide and 2 ft thick. Some 75% fell within 25 ft of

Trend Markers—Roof Control

Quantity and quality of support per ton of output steadily increasing.

Bolting, having passed the mark of use for over 50% of the bituminous output, continues to increase.

More emphasis being placed on design of bolting and other support systems to cut the cost of supports while still providing required protection.

Recovery of both timber and bolts being increasingly practiced where conditions permit such recovery with safety.

Special equipment and plans being evolved to provide support in continuous mining without interrupting production.

Future Possibilities

Increased use of European-developed types of steel posts and supports.

Gluing of roof strata together to increase the strength of the roof beam.

Case-Finders—Roof Support

Posting in Conveyor Mining—Plans for both face-conveyor and self-loading conveyor setups, 20- to 35-ft-wide places, 46-in coal. *Coal Age*, July, 1956, p 65.

Bolting Formulas—USBM-developed formulas for calculating bolting results. *Coal Age*, August, 1956, p 85.

Checking Bolting Results—How to ascertain plug position, torque requirements and holding power of bolts. *Coal Age*, September, 1956, p 92.

Holding Top at the Face—Top characteristics; coal, timber and bolts as supports; installation for maximum effectiveness. *Coal Age*, November, 1956, p 77.

Preventing Prop Dislodgment—Chain-and-bar safety device keeps props in place during shooting. *Coal Age*, March, 1957, p 90.

Bolting With Truck-Mounted Drills—Mounting two bolting units on crawler truck results in an increase of 60 to 70-tons per section per shift. 45-in average-height coal. *Coal Age*, April, 1957, p 74.

the working face, where 4 to 10 men customarily worked. The possibility of such falls is the major reason for emphasis on ample timber installed according to a fixed plan, and on the use of safety posts, jacks and bars in the face working areas.

One question with thin, relatively weak roof layers over the coal is: "When to take down and when to leave?" Sometimes the material is so weak and crumbly that the question becomes academic, since there is no practicable way of keeping it up. Roof-bolting with channels, bars and short headers or capboards has made it possible at times to support top that otherwise could not be handled and which, when thick enough, rendered mining doubtful or impossible because of cost, hazard or both.

Depending on coal price, seam thickness and volume to be handled, a certain thickness of top material can be taken with the coal in room and pillar work. However, when this thickness reaches 6 in or more, the chances of economical production are considerably reduced if not completely eliminated. The rule, therefore, is to hold top material in working places, especially since support commonly is necessary for other purposes. There are exceptions, of course, to meet special conditions. In permanent or semipermanent openings, the answer is "Yes and no." One of the conditions, for example, which might lead to a decision to take top, is a weak or crumbly drawslate over which is a good slate or sandstone. To save lagging of the slate, cleanup later on or both, the top would be taken to the hard material in installing support.

2. Rib and Face Falls—An alternative form is sloughing, which may be defined as minor face and rib falls, with spalling a minor form of sloughing. Rib and face falls also are of the type classed as accidental. Under certain conditions—thick, pitching coal, for example—such falls represent a real hazard. Sprags against the face and posts with plank stringers or lagging along the ribs are among the safeguards.

3. Squeezing—In its commonest form, squeezing is the slow increase in weight on pillars or solid coal eventually resulting in such things as crushing of the coal, heaving of the bottom and the driving of pillars into soft floor or top. The cause normally is leaving pillars or other support which, after considerable area is opened up, proves to be inadequate, permitting the top to settle gradually with transfer of the weight to active places and solid coal. Most old-timers maintain that once a real squeeze starts nothing will stop it until settlement and readjustment are complete.

An alternative to squeezing is sudden collapse, which may also occur after a period of squeezing. Like squeezing, sudden collapse is rather infrequent, but it does occur, especially where thin room pillars customarily are left, or where a strong member in the top results in the creation of a large open area without a fall in pillaring. One of the effects and one of the several hazards is the ensuing air blast which, in the magnitude sometimes attained, in addition to wrecking doors, stoppings and other structures, can knock cars off the track and throw people around sufficiently hard to cause severe injury or death. Preventives include ample pillar area and careful attention to getting initial breaks quickly.

4. Bursts or Bumps—These are the sudden, explosion-like failures of coal as a result of internal stress caused by weight. In most instances, conditions conducive to bumping include heavy cover with strong members and especially a strong member close to the coal; a point at which weight and stress tend to concentrate, as the apex of two converging pillar lines, a barrier pillar sticking out into the gob, and so on; and a strong floor. As noted elsewhere in this "Deep-Mining Guidebook," drilling and augering can be used to trigger bumps or unload stress before it becomes too great. The basic line of defense, however, is adjustment of the mining plan to prevent stress buildup. Some suggestions are:

Get all the coal. Clean out timber also, since leaving props and cribs can help set up conditions conducive to bumps.

Mine pillars as fast as possible—at an even rate. The quicker pillars can be mined, the shorter the period of time for stress development.

Orient the pillar line with the natural fracture system of the roof to promote caving in the gob, thus preventing the formation of long roof spans. If long spans cannot be avoided, some means of support should be provided to prevent breaking. Cribs are an example.

Keep development out of abutment or stress areas next to pillar lines and gobs, and develop for new pillars away from rather than toward such areas.

Adjust mining to prevent the formation of points on pillar lines. Keep lines even—no projections into gob area.

Keep pillars as large as possible to reduce the chance of failure under stress. Uniform size and shape keeps stress even and prevents concentration on certain large or odd-shaped pillars.

Mine individual pillars open-end where possible and keep lifts fairly narrow.

5. Intentional Caving—Since caving relieves the remaining coal of weight—at least in substantial measure—and thus eases the job of mining and support where pillars are removed, much of the roof action in mining is intentionally induced. A common goal is a fall each time a lift is taken off a pillar, and this goal is fairly easily reached under conditions ordinarily encountered. Thus, support is provided to (a) break the top at the edge of the new lift and (b), with other support as necessary, to hold the top within the lift and keep it open.

Roof action in intentional caving commonly takes place in two to three stages. The first, or initial, break snaps the roof off at the breaker line. The cave commonly extends 25 to 50 ft up into the main roof. This is followed by a secondary cave spanning several of the initial caves, and extending up to, say, 150 to 300 ft. If this is not sufficient to take the action to the surface, a third cave and general settlement normally occurs. Usually it is of sufficient magnitude to reach the surface unless the cover is exceptionally thick. Where subsidence is limited by packwalls or some other form of support, the initial strata may be cracked as a result of bending in the slow subsidence but falls of the type encountered in complete caving are relatively infrequent. Also, roof action, aside from a gradual and limited subsidence, seldom extends to the surface.

Timbering

Match type of support to the specific job, whether permanent or temporary.

Study timber types and support methods to get the most economical support possible in relation to conditions.

TYPES OF SUPPORT in the "timber" classification range all the way from roof jacks at the face to steel, concrete and brick linings in permanent openings. Between these limits, timber includes posts, legs and bars of wood, steel and aluminum; yielding arches and rings of reinforced concrete and steel; concrete, brick and masonry columns, piers and abutments; such supplementary items as wedges, capboards, headers and lagging; and coal itself. Other forms of support, in addition to timbering, are bolting, and coating and sealing, discussed later in this section.

Permanent Timbering

The goal in permanent timbering should be "permanence," meaning that life of the support, within economic limits, should match the expected life of the opening. This is not an absolute rule, however. In ground where movement can be expected for some time until the measures stabilize (longwalling, or driving gangways through previously worked ground, for example), it may be desirable to make the initial timbering job a temporary one, replacing it with final permanent timber when things have settled down.

MOBILE TIMBERING MACHINES cut cost of adequate face support while facilitating adherence to standard plan.

HAND-PUMPED HYDRAULIC LIFTER here eases job of replacing heavy set. Truck mounting facilitates movement.

TIMBER RECOVERY is facilitated by power winches mounted on crawlers or built onto gathering locomotives.

As an example of "permanence" which is not permanent, consider the case of untreated wood with a life of around 3 yr in a haulage heading with a life of 10 yr. Since treated wood normally will last at least 10 yr, it could be considered "permanent," whereas with untreated wood the initial installation would have to be replaced at least once and probably twice, with each replacement normally more expensive than the original. The moral is that within limits it is better to spend more at the start for permanence, not only to eliminate replacement, and also production stoppages as a result of falls, but to keep routine maintenance as low as possible. When timber is installed so that it doesn't rot, fail under load, or permit sloughing and spalling, as examples, conditions are most favorable for keeping maintenance to the bare minimum.

Conversely, of course, timber or support life can be excessive—and thus excessively costly—in relation to life of opening. As an extreme example, it would be wasting money to line a 5-yr-life opening with reinforced concrete, though a sand-cement mixture an inch thick on wire might well be the thing for this particular application.

Lining—Support by complete lining is limited to rather special situations in mining. These include: soft sections of top near the outcrop in a permanent drift opening, or other soft or broken areas, as under stream valleys; and permanent long-lived openings on shaft or slope bottoms. Reinforced concrete is the old reliable in heavy-duty linings, and also provides complete sealing. Sealing with some support is provided by sprayed-on sand-cement mixtures, though support is only nominal when, say, the coating is only ¼ to ½ in thick. When applied over wire and in thicknesses up to 1 or 2 in, they provide some holding power in addition to sealing. Steel liner plates also provide sealing with a considerable degree of support, and are low in cost and easy to install, using a concrete footwall as a starting point.

Grouting—Though not strictly lining or coating, grouting has been used to strengthen top in sections of permanent openings under, for example, stream beds where the overburden is thin and the top is rotten. Elimination of water seepage may be a secondary goal. Sometimes it is the major one, with strengthening of the top as a collateral benefit.

Piers and Abutments—Supports of these types usually are found at pillar points where openings fork, and at other places where considerable resistance to roof movement is necessary. They may be built of concrete, with or without reinforcement, concrete or cinder blocks, brick or masonry.

Yielding Arches and Rings—Where weight is substantial, the top is badly broken, and there is a possibility of movement of the ground in which the opening is made, yielding arches or rings may be installed. Some types employ concrete blocks put together on the keystone arch principle. Of the steel types, the latest in the U. S. (*Coal Age*, April, 1954, p 92) is the full-round with joints that slip and thus permit diameter to decrease without deformation until equilibrium is re-established.

Three-Piece Sets—Probably the widest used of all forms of permanent timbering, the three-piece set—a crossbar supported on legs at each end—may range from a simple affair put together at the site up to a preframed and largely standardized set designed for heavy duty. Wood is the commonest material. As noted previously, it should be treated where life of opening is expected to exceed about 3 yr. The set also may be made of steel or may consist of wood legs and a steel bar where extra stiffness and resistance to bending are desired. If steel legs are used, they should be set on concrete piers or low footwalls for maximum stability, especially in longer-lived places.

Wood is easy to obtain and work, and the three-piece set is both flexible and adaptable. Also, it supplies the required degree of support except under exceptional conditions, in which case special concrete or timber arches are about the only answers. Legs, however, reduce clearance and can be knocked out to cause, in many instances, severe falls, aside from the fact that they themselves represent an expense.

Two-piece sets are an alternative to three-piece under certain conditions—for example in a water-level gangway in pitching coal where one end of the bar is hitched into coal or rock and the other is held on a leg.

Hitch Timbering—To eliminate the leg and its hazards, bars may be installed in hitches either cut or drilled in the rib. Hitch holes may be provided for each individual bar. As an alternative, holes may be drilled some distance apart to accommodate pins. Steel bars are then laid on these pins and the regular bars are placed on these stringers. Properly done, hitch timbering is permanent, especially if treated wood or steel bars are employed, and cost of installation (labor and materials) is much less than installation of a regular three-piece set. Routine maintenance and cleanup are cut to a minimum.

Lagging—Spalling of top and sloughing of ribs are the reasons for the installation of lagging, which may be small natural round timber or sawed material. In long-lived openings lagging, like main timbers, should be treated. Lagging also provides some support, but its major function is holding loose roof material in place.

Single Posts—These have a wide use in permanent support, especially in openings where the spacing can be cut down, as in airways, manways and belt headings, or where the roof needs some support but a span of, say, car width can be tolerated. Short headers may be used to increase holding spread in tender top. As with bars and lagging, permanent posts, together with wedges and headers, should be treated.

Coal—Coal itself is widely used as a means of protecting and supporting top, though the support is chancy and not too great from the standpoint of resistance to weight. Sealing of the regular top is perhaps coal's major contribution.

Temporary Timbering

Temporary support naturally finds its widest application in the active working areas, including the working face, the room and the room entries. The major objectives are perhaps three:

1. **Protecting men.** The average dimensions of roof falls resulting in fatalities is given by the Bureau of Mines as: length, 13 ft; width, 11 ft; thickness, 2 ft. The majority of these falls (75%) occur in the face area inby the last permanent support, and 95%, says the bureau, are a result of human failure, meaning in turn primarily failure to install proper support.

2. **Keeping workings open.** The aim here is to preserve access to the face area from which production comes.

3. **Holding top during pillar removal.** Here, the support

should have sufficient strength not only to hold the place open as long as necessary, but also to break the top at the desired point and thus help initiate the caving process.

Standard Plans—The key factor in temporary support, particularly in the critical area within 25 ft of the face, is a plan for minimum support rigidly adhered to and supplemented with additional support where there is any doubt that the minimum is insufficient. The fact that nearly a third of the roof-fall fatalities occur where a timbering plan has been established is reason for emphasizing the need for supplementary support.

Face-Area Support—If coal is to be produced, both machines and men must work in the face area, which also means that timbering must be planned to permit reasonably efficient mining while at the same time providing maximum protection against all the hazards of newly exposed top whose condition is largely unknown. Among the specific hazards are slips, clay veins, kettlebottoms and the like, aside from general weakness, as in the case of certain drawslates, clods and the like. Also, unless caught, certain roof members will separate and sag, thus requiring more attention than if they had been secured immediately. Swelling or disintegration as a result of moisture are additional difficulties that may crop up in face support.

The first line of defense in face support is the safety post or safety jack. The latter has the advantage of being easier to install, as well as to move to permit machines to pass. Interference is relatively little with hand-loaded conveyors but increases progressively as mining moves toward mobile machines. The crossbar is one logical answer to keeping support close to the face while at the same time keeping down interference. Where the coal is low, crossbarring, especially if weight sags the bars, may result in too-little clearance for mobile equipment. This has resulted, in some mines with poorer top, in conveyors being chosen instead of loaders.

Face support plans are almost infinite in variations but the general routine is to extend posts or crossbars to the face immediately after loading to protect the cutters, drillers and others engaged in preparing the next fall. Roof jacks may be used to protect machine operators specifically and saddle jacks may be employed under bars to permit movement for cutting with shortwalls. Then, after shooting, the top may be caught by safety posts or jacks as soon as an appreciable area is exposed by loading. Thus, support is provided whenever there is an opportunity for installing it.

Protection for loader and miner operators who are relatively far back from the face, commonly is provided by crossbars spotted over the machine and either left in place or moved up. Use of bars of course is dependent upon sufficient height for clearance. Handling bars in the face zone, particularly where they are moved ahead each time a cut is made, is somewhat of a problem, particularly, if metal or heavy wood is needed for strength over the necessary open spans. As a result, a number of operators employ aluminum H-sections which are both stiff and light for high holding power and ease of handling. One mine, as an example, keeps two such bars in each place, moving them ahead when each cut is completed.

Pillar Support—In addition to the regular protection of men, machines and working places, support in pillar sections usually functions as a top-breaker also. Coal itself is a form of support, either as stumps, thin straight fenders, or sawtoothed fenders made by gripping or cutting out on the gob side, as examples. Frequently, a part or all of this coal may be recovered, and even if it is not, it represents a support cost considerably less than the conventional timbers or cribs. Artificial support, as in solid work, consists of jacks, posts and bars used much the same way, plus cribs and breaker timbers, both the latter primarily to break the top and at the same time protect rooms and pillar places against the riding over of caves.

Heavy weight or other special conditions may warrant special measures in roof support during pillaring operations. At one mine, as an example, the first step in mining a block open-ended is to crib it on the two sides next to the gob, supplementing this with similar cribs on a number of neighboring blocks. Overburden at this operation ranges up to 1,500 ft in thickness and the immediate top is 40 to 80 ft of sandstone. At another property, the machine operator is protected in recovery of the final corner stump at the intersection of the pillar split and room by erecting cribs on each side of the space in which the machine advances in mining the stump.

Room and Room-Entry Support — Depending upon equipment and mining plan, "permanent" room and room-entry timbering starts at from one cut up to 25 ft back of the face. Usual types are posts with or without capboards or short headers, and three-piece bar-and-leg sets. With topcutting in thick coal, legs may be eliminated by gripping out with the cutter bar to form slots into which the bars may be slid.

Steel Supports—Roof jacks until recently have been about the only substitute for wood posts in working places. Old rail has been used in the past and some attempt has been made to employ light shapes, corrugated strips and other steel members.

The advent of the coal planer and similar types of equipment brought the European-developed steel posts and steel post-and-header combinations into the picture in the United States. Their main application is on planer and slicer faces, but they are being considered in some quarters for certain other applications. Design features leading to such consideration included high load-carrying ability, provisions for yielding and thus guarding against sudden collapse through support breakage, and quick installation and release.

Timber Economics

If a place makes 25 tons and a post costs 75c to buy and the same to install, the cost per post is 6c per ton. Therefore, particularly where no recovery is contemplated, support methods, materials requirements and possible recovery should receive intensive study. Elimination of fatalities and injuries, and the promotion of efficient mining are, of course, the overriding goals and should not be jeopardized by stinginess in timbering. However, since even saving one post per cut amounts to considerable money per ton, a change in the posting pattern—perhaps by staggering, as an example—can achieve this saving and still provide the requisite support and protection. Where bars and other more-expensive items are involved, the desirability of close study and economy becomes even greater.

Timber Installation—Even though it may prove impracticable to reduce the number of timbers set—particularly crossbars—substantial economies in setting cost can be achieved by timbering machines, now available in a number of types with both rail and rubber-tired mountings. The first commercial design for a timbering machine was developed around 10 yr ago, and one of the

ROOF-BOLTING WITH CHECK TIMBERS provides permanent support of airway roof with minimum obstruction of air flow.

BOLT RECOVERY usually employs hand tools. Safety posting is essential and men should work in pairs for protection.

SPECIAL BOLTING PLANS include this example of short channels and wire mesh to protect intersection at crosscut.

first installations saved its user 12c per ton in reduced labor for timbering and higher tons per loading-machine unit.

In addition to mobile units, small hand-operated lifts have been developed for replacement and installation of crossbars in entries and gangways. They are designed for mounting on one end of a flat-bed car or truck.

Even without special machines, the timber crew's work can be lightened and its capacity increased by the use of timber jacks to take the manual labor out of raising crossbars. And in thick coal, where universal cutters are employed, the cutter bar may be pressed into service to lift bars into place.

Salvage—The practicability of recovering posts, bars and other timbering material depends on (1) whether it is safe, (2) whether, as with the customary untreated material, decay has left it with little useful life, and (3) the cost of recovery. If these and other questions can be answered affirmatively, recovery can then proceed, but only on the basis that adequate temporary support be installed before the post or bar is removed, or that removal be done from a safe point.

Removal sometimes is synchronized with making falls in pillar mining. Supports may be pulled one by one from a remote point using the old-reliable hand-operated postpuller, or "sylvester." Greater economy and the ultimate in safety is achieved by pulling supports in groups with a power winch, wire line, and chain or chains. Some coal companies, for example, have mounted motor-driven winches on old locomotives to convert them into mechanized pullers, while others have put the winches on crawler-type shortwall trucks. Even with the best of equipment, recovery is only a fraction of the total timber installed, though a sizable one in many instances, with consequent over-all reduction in cost of posts and bars. In some instances, posts and bars have been reclaimed and re-used as many as five times.

Roof-Bolting

Design the bolting pattern to give the desired protection yet keep cost of bolts and installation down.

Provide good anchorage and tension properly for maximum reinforcing power.

Check installations periodically to guard against loss of tension.

THE FACT that roof-bolting has grown in about 10 yr to the point where it provides support for over half the bituminous coal mined reflects, among others, the the following advantages.

1. **Better Support** and consequently fewer injuries and fatalities from falls. According to Bureau of Mines, it is 5½ times safer to work under bolted top, compared to timbered. One reason is that bolting lends itself better to the development of definite patterns, and to closer adherence to the patterns after development. Clearance—either side or top—is not reduced in bolting, and there are no timbers to be knocked out.

2. **Higher output** per man and machine as a result of more working room and no interference.

3. **Less bulk in support material** to be stored, handled and transported.

4. **Better coal cleanup.** In some instances, loss of coal behind timbers is as much as 5% of the total or more.

5. **Higher extraction** as a result of good top conditions and fewer or no falls throughout life of place.

As an example of these and other advantages, one operation found that roof-bolting was directly or indirectly responsible for the following benefits:

1. An 80% decrease in accidents of all kinds.
2. A 50% decrease in resistance to air movement by eliminating obstructions.
3. An increase of 5 in in headroom.
4. A 70% increase in production efficiency because of elimination of interference and falls and other improvements in working conditions.

In some instances, all these advantages—or many of them—have been secured with an actual reduction in support cost as a result of bolting. Normally, however, bolting cost, everything considered, is slightly higher than conventional timbering, but is warranted because of the advantages enumerated previously, as well as others.

Bolts broke into coal mining as a means of roof support in solid work. They then moved into support in pillaring and also are used to prevent heaving of bottom and the sloughing or caving of coal or rock ribs in shafts, slopes and entries. In addition to the usual steel bolt, wood pins are being used to a limited extent for the same purposes, i. e.: holding top and stabilizing ribs. Bolts, however, are not a universal cure-all for roof troubles, and conventional timber may be better from all angles under certain conditions.

Bolt Types

Roof bolts normally function by pinning a number of weak members together to form a strong beam. A somewhat rare function is hanging loose lower members to a strong upper member. In beam-building particularly, the desired result is attained by anchoring the bolt and then screwing a bearing plate up against the top. This, it will be recognized, puts the bolt in tension and makes the beam-building action possible. Unless the bolt is tensioned, there is no beam action, and unless tension can be achieved, meaning that an anchoring stratum or horizon must be found, other means of support normally must be employed.

The object in bolting is reinforcing the roof and thus increasing its resistance to sagging and failure. If the roof is good it may be necessary to increase its natural resistance to failure only one-half, as an example, meaning that only a minimum of support is necessary. But as its natural resistance to sagging and failure decreases, the reinforcement factor increases. Thus, for top that is inherently weak, it may be necessary to install support that will multiply its natural resistance to failure as much as 3 to 4 times.

Split-Rod-and-Wedge—Properly installed in rock of the right type, load-carrying characteristics of the split-rod-and-wedge bolt are excellent. It is easy to install and is not weakened in the installation process. However, it requires compressed air for driving and thus may require the purchase of compressor equipment. The extra step of driving the bolt into the wedge increases installation time approximately 20%, and cost of materials usually is higher. It loses its holding power more readily in the softer, semiplastic rocks and protruding bolt ends are a hazard, though they may be clipped with special bolt cutters.

Expansion-Shell—Requires no driving to anchor, is better suited to softer semiplastic rocks, is normally cheaper—about 25%—and can be installed in shorter time. However, it is more difficult to tension properly, and maintenance of tension is difficult in soft material.

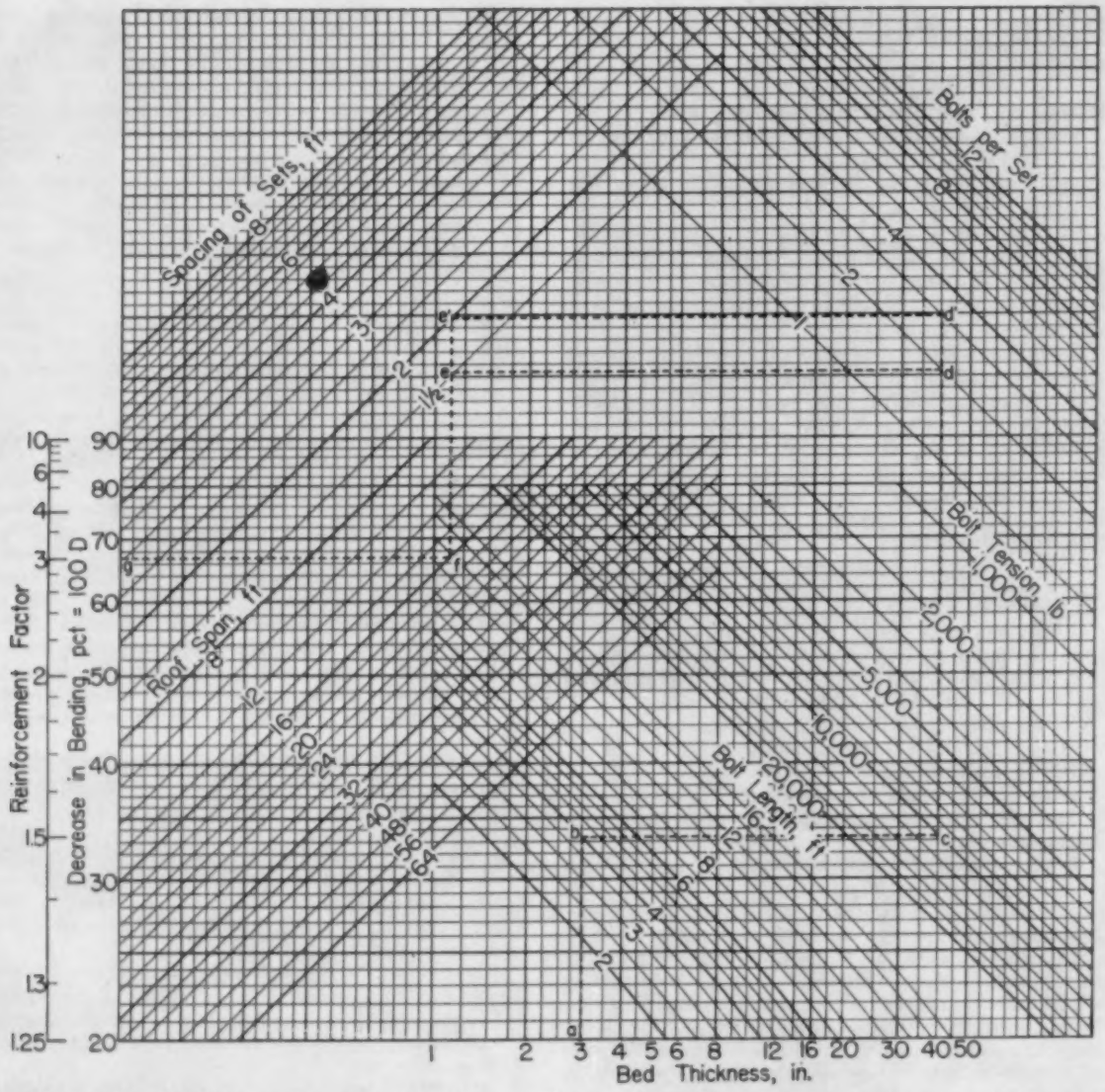
Bolt Sizes—The usual sizes of bolts today are 3/4 and 5/8 in. The 5/8-in bolt in high-strength steel has a maximum yield load of 9,040 lb, compared to 10,020 lb for regular-strength steel in the 3/4-in size. In the 5/8-in size, the weight of 100 4-ft-long bolts, rolled threads, unchamfered square heads, is approximately 350 lb. The weight of 100 of the same bolts in 3/4-in size is 510 lb. Thus, with the same holding strength the saving in steel is nearly 30%.

Plates usually are 6x6 in, though other sizes are employed. Embossing can give the same bearing strength with a considerable decrease in thickness, and consequently such plates are used by a number of producers.

The 5/8-in bolt, incidentally, offers another advantage where tension dropoff is experienced as a result of plastic flow of top materials, movement of top strata and/or shrinkage of headers (*O-B Haulageways*, September, 1956). This reflects the fact that the 5/8-in bolt has approximately 42% greater linear deformation than the 3/4-in regular. Thus, if a 4-ft bolt of each type was installed to a tension of 10,000 lb, and roof movement later reduced the stretch in each by 0.030 in, the tension would drop to the following: 3/4-in, 3,600 lb; 5/8-in, 5,300 lb. The higher figure for the 5/8-in bolt might mean the difference between failure and continued holding of the top.

Cemented Bolts—A recent introduction is the cemented bolt. Cementing naturally increases the cost substantially but does insure a permanent anchorage, especially in soft strata. It is offered primarily for long-lived permanent openings where the extra cost is less a factor.

The design (*Coal Age*, May, 1957, p 120) is based on the use of a reinforcing bar instead of the conventional bolt, plus a perforated sleeve. The sleeve is placed in the hole and filled with mortar. The reinforcing bar is


Spacing of Sets, ft
Bolts per Set
Bolt Tension, lb
Bolt Length, ft
Roof Span, ft
Reinforcement Factor
Decrease in Bending, pct = 100 D
Bed Thickness, in.
1 2 3 4 5 6 8 12 16 20 30 40 50
10 6 4 3 2 1.5 1.3 1.25
90 80 70 60 50 40 30 20

BOLTING DESIGN CHART developed by U. S. Bureau of Mines facilitates design of bolting systems which provide the required support with a minimum expenditure for bolting materials.

then driven into the sleeve, forcing the mortar out through the perforations and filling the hole. Claims for the process include uniform anchorage throughout the entire length of the bolt, uniform stress, and elimination of corrosion.

Bolting Patterns

As with timbering, the pattern with bolting must be adjusted not only to conditions at each mine but also to variations within each mine. And since an individual bolt in place seldom costs less than $2, including equipment maintenance and depreciation, etc., saving even one per cut, provided safety is not jeopardized, is a worthwhile economy. By the same token, auxiliary forms of support should be omitted unless they contribute to holding power and safety.

Auxiliaries, however, are a necessity under certain conditions. For example, if the roof is tender or contains slips, cleavage cracks, kettlebottoms, and the like, wood headers or crossbars on the bolts, including steel channels or ties (sometimes with wire mesh) in permanent openings, are as much in order as if posts or legs were being set. Mixed bolt and timber plans, as a matter of fact are fairly common. For example, though bolting can result in compacting the roof members, it may not provide a beam with all the strength necessary, especially over the longer spans. However, it does provide a great deal of the required holding power and makes the conventional timbering less complicated and costly, in turn reducing the over-all cost of the entire support job. Also, since bolts do not show subsidence, posts may be installed in pillar places as indicators of weight and convergence, aside from providing backup support in final recovery operations.

Where bolts are used alone, a check of published descriptions apparently indicates that the majority are placed on 4-ft centers, compared to 4 to 5 ft with crossbars and individual posts. Special patterns for long spans or weak top include the "star" (a bolt in the center of a

four-square pattern). Also, under some conditions, making part of the bolts—say every other one—longer may be helpful.

Designing Bolting Systems

Based on the results of model testing (USBM R.I. 5155, "Design of Bolting Systems," and 5156, "Reinforcing Bedded Mine Roof With Bolts"), the U. S. Bureau of Mines has developed a general procedure for designing a bolting system. Based on a roof-bolting design chart, illustrated, the procedure is as follows:

1. Take as a first approximation of average bed thickness a figure arrived at by dividing the observed thickness of the roof section and dividing by the number of separate laminations. Use of the average results in conservative design. Laminations thicker than the average result in a higher reinforcement factor than the chart, which applies where all laminations are the same.

2. Choose a bolt length that will assure firm rock at the anchorage horizon. This may depend upon the results of tests (Item 3).

3. Conduct tests to determine bolt-anchorage capacity (R.I. 5040, slotted-type bolts, and R.I. 5194, expansion-type). Choose as the design value for the bolt tension either the anchorage capacity or the following, whichever is smaller: 10,000 lb for a wedge-type mild-steel bolt or 8,000 lb for a 3/4-in mild-steel expansion-shell bolt. However, if experience shows a significant loss of tension after installation—say to 5,000 lb a month later—this lower figure should be used.

4. Choose the number of bolts per set so that the spacing within the set (span divided by the number) is not excessive. For most mines the maximum safe distance between bolts is estimated at 4 to 6 ft. The minimum bolts per set can be determined from roof-condition experience at the particular mine. A logical procedure would be to decrease the bolts per set in steps, each time decreasing the spacing as required by the design chart to keep the reinforcement factor unchanged. Bolt-to-bolt and bolt-to-rib spacing should be approximately equal in the set.

5. Choose a trial value for spacing between sets along the opening not greater than the spacing across the opening within the sets.

6. Using the desired roof span, construct the line A-B-C-D-E-F-G on the chart.

7. If the reinforcement factor is less than 2, decrease the set spacing and/or the roof span, and increase the number of bolts per set and/or the bolt length. A change in spacing and/or span will have a greater percentage effect.

Results achieved in bolting a particular roof should indicate whether the existing reinforcement factor, as determined from the design chart, is adequate or should be increased by modifying the existing bolting system. In the absence of previous experience the minimum reinforcement factor should be 2; otherwise bolting is not justified. Conversely, if the existing bolting system is judged to be effective, the design chart may be used to develop a system that is less costly.

Bolt Installation

Split-rod-and-wedge bolts require a percussion tool for installation, which in turn requires compressed air. Since bolts of this type were the first to be developed, air was the first bolting medium, being used both for drilling and driving.

Air still is the preferred medium for drilling the hard rocks encountered in mine roofs, even though electric rotary drills have been taking on harder and harder material. Portable compressors are widely used, though central stationary units have their advocates, who state that the advantages include plenty of air at rated pressure, lower maintenance and less trouble with dirt and water in air lines. Portables may be mounted on rubber or crawlers, or may be carried in shuttle cars. They may be sized to operate one or two stopers, but in any event they should be capable of supplying drilling needs without drop below rated pressure.

Rotary Drilling—Development of the expansion-shell bolt put the rotary drill very much into the roof-bolting picture. Now a wide variety of machines are available and they are being built for harder and harder rock, though they still cannot cope too well with the hardest types. Ability to vary speed and pressure is a very desirable drill characteristic. In soft drilling, high speed and low pressure usually give the best results. In hard cutting, reducing rotational speed and building up pressure results in better cutting, especially with the proper design of bit head.

Length of drill should be as short as possible for maximum strength. Ejection of material in rapid drilling may make the use of a conveyor-type auger desirable. Spiral flights may also serve another purpose, i.e.: eliminating the offsets which tend to occur when passing from soft to hard rock, with subsequent breakage of bails as the bolt is run up. Spirals almost the diameter of the hole prevent this occurrence.

Proper operation and maintenance of rotary and other type of roof-bolters have a significant bearing on costs and results. If possible, the manufacturer should be afforded an opportunity to explain the operation of the machine to the maintenance superintendent, foreman and driller, with special attention to showing the driller the relation of thrust and rotation to penetration and bit wear. Regular inspection, proper lubrication and cleanliness are basic approaches to the problem of keeping maintenance down. Also important is having the maintenance superintendent and manufacturer determine proper pressure adjustments. Pressures should be checked regularly and should be adjusted for changes in roof conditions.

Bits—Drilling with dull bits results in overheating and damage to the bits, in addition to damaging machine parts because of excessive stresses. Bits ground off-center or with one short cutting lip result in hole enlargement, making proper anchorage impossible in some materials. The same effect also results from allowing bits to spin or "dwell" too long at the anchorage horizon. Worn bits, loose-jointed drill extensions or drill whip can result in undersized, "dog-legged" or rifled holes.

Bit type and care thus become important items. Recommended steps include:

1. **Work with bit manufacturers** to get the proper carbide and design.

2. **Consider the use of two or three sizes of bits** to reduce wear through loss of gage and speed up drilling.

3. **Match thrust and rotational speed** to conditions for maximum penetration and minimum bit wear.

4. **Employ trained men** for sharpening and reconditioning bits.

5. **Keep a bit-sharpening record,** and a record of holes drilled and bits lost or destroyed.

6. **Determine bit needs** per shift, all sizes.

7. **Provide driller with two strings of bits so that** while one string is in use the other can be sharpened.

8. **Use bit record** to determine if the machine needs adjustment, roof conditions are changing, or the driller needs instruction.

Dust Collection—Of the two main methods of suppressing dust—water during drilling and dry collection—the latter is forging ahead because of the inherently greater complications of water. The simplest form of dry collector consists of a flexible collar held against the roof to collect the cuttings and drop them into a bag or onto the floor. More positive means of collection and disposal are provided by vacuum units operating through collars around the drills or, in the latest, by pulling the cuttings through hollow bits and drill steel.

Dry dust collection, however, has been found inadequate under some conditions though normally it is generally preferred. Drilling in hard sandstone at one operation, as an example, became impracticable with dry collection. Tanks and pumps were installed to feed water up through the hollow drill rod, making it possible not only to drill the rock but rendering dust collection unnecessary.

Anchoring and Tensioning—Anchorages vary in accordance with the type of rock, with corresponding effect on the maximum tension possible. And without anchorage there is no possibility of achieving tension and consequently there is no reinforcing effect. Naturally, other things being equal, a better anchorage can be achieved in hard sandstone. In fact, in such material it is possible to break the bolt before it pulls out. In soft shale, the opposite is the case and the bolt will pull out before it will break. However, a certain degree of tension can be achieved even in soft material and this frequently is enough for the purpose, or enough to reduce the need for supplementary timber.

Correct hole size is a major factor in good anchorage and ability to tension properly. Undersirable variations include oversize, undersize, "dog-legging" and rifling. Periodic checks with a hole gage is a major method of revealing such faults before they become serious enough to cause trouble.

Proper installation is another factor in good anchorage. With expansion-shell types, this includes positioning of the expansion units so as not to use up thread and thus increase the possibility of not being able to develop full tension because of running out of thread. Check plug and shell position periodically by removing sample bolts to see that proper anchorage is being achieved.

Under average conditions, 50 to 80 lb of tension is developed for each foot-pound of torque. If 60 is taken as a conservative factor, about 150 ft-lb of torque will develop 9,000 lb of tension—well below the yield point of a 3/4-in mild-steel or 5/8-in high-strength bolt, assuming the bolt bears against a plate that is level and that there is not excessive upward pressure to generate additional friction.

Torques up to 200 ft-lb may be employed in hard material. In very soft top, where anchorage capacity is limited, bolts may be tightened with a hand torque wrench to determine the suitable setting for the bolting machine.

Bolt head and roof plate should be firmly against the top before tightening begins to make sure that the maximum thread length is available. Excessive torque may be wasted in hard top as a result of galling between bolt head and plate. If the plate is not level the bolt head may be twisted off at over 175 ft-lb.

Caution should be observed with wood headers to make sure that tension is preserved. Wood can dry out, yield under pressure and otherwise change characteristics with loss of tension. Never install a wood header, crossbar or capboard with a nut alone. Always use a steel bearing plate.

Other factors involved in good anchorage and tensioning include machines in good adjustment and the use of the correct bolts, shells and washers for the job.

Checking Tension—The ultimate in accuracy and perhaps the best method of determining the efficiency of the bolting job is the pull test with a hydraulic ram. Between such tests a hand torque wrench should be employed at frequent intervals to check the accuracy of the torque setting of the wrench or bolting machine.

After installation bolts may lose tension for any of a number of reasons, including plastic flow of the rock at the anchorage point, movement of the strata, drying out or yielding of the headers, crumbling of protuberances under the bearing plate, and so on. As noted, the handy device for spot checking to see if a tension dropoff warrants retightening is the hand torque wrench.

Two types of visual indicators are available for permanent installation on, say, one bolt out of every 10 or 12 to show whether tension has dropped off. One consists of two circular plates between which a layer of rubber has been bonded. As the device is placed under tension of compression the rubber expands or contracts, and the relationship between tension and torque, or the relaxation of tension in use, can be determined by using a special compression-pad gage.

The second indicator comprises specially forged self-centering-head bolts, specially embossed plates and concave steel-spring washers. They change shape as the load is applied and change back when tension drops to a certain value.

Concurrent Bolting

Continuous miners, since they are designed to stay in one place all or most of the time, have presented some problems in attaining the benefits of bolting, as well as problems with conventional timbering also. These problems have been accentuated with the growth of conveyor transportation, which further limits the opportunity for using separate bolting facilities.

Concurrent bolting is one answer. Used so far primarily with ripper-type machines, it involves mounting a bolting machine on each side of the miner immediately ahead of the operator. The mounts permit angling the drill in or out a maximum of 25 to 30 deg.

As the machine makes one sweep across the face two holes are drilled to the outside and two bolts installed. The time of bolt installation is of course less than the time of the face sweep. Then, when the machine moves forward for the next sweep one drill may be angled in and another bolt placed. The other drill may be angled on on the next sweep and another bolt placed, after which the cycle is repeated. Other arrangements and cycles also may be employed, remembering that the goal is good roof coverage without stopping the miner.

It will be recognized that concurrent bolting can practically eliminate stopping the machine to install supports. The additional production can be as much as 20 to 25% where such bolting is possible. In addition, no member of the crew, except the bolters, is exposed to unbolted top. Even the bolters are some 12 ft or so back from the face.

Bolt Recovery

Since, as with timbering, except on pillar lines, it is estimated that not more than one bolt in 10 is ever called upon to actually support top material, salvage almost automatically becomes a matter for consideration, since whether the bolt is holding top is a major factor in determining whether recovery is possible. Even if most of the bolts were supporting top, salvage would still be possible by installing protective support, but the hazards are substantially greater and the savings possibilities correspondingly less.

Recovery operations so far are limited almost entirely to the expansion-shell type of bolt. Under favorable conditions, recovery cost is ¼ to ⅓ the cost of a new unit, including expenditures for new shells and nuts to go with bolts and plates that have been salvaged. Hand salvage is the rule, and a basic principle is setting roof jacks or safety posts before any attempt is made to remove a bolt. A second principle is at least two men to a salvage crew, since two heads can be better than one in guarding against hazards, and the second man, in case of trouble, can, in many instances, prevent an accident from turning into an injury or fatality. Experience so far indicates that a two-man crew can recover 200 to 300 assemblies in a shift.

Continuous-Miner Plans

Make sure that operator and other crew men are under supported top at all times.

Design the support system to keep operating interruptions to a minimum or eliminate them entirely by, for example, concurrent bolting.

THE CONTINUOUS MINER, as previously noted, presents some tough problems in achieving support without interruption, and these problems are accentuated when conveyors are used for transportation. In return, however, certain miners contribute a benefit in the form of arched or elliptical openings which definitely increase the resistance of the top to sagging and failure.

Unless concurrent bolting is practiced (see previous material on "Bolt Installation"), interruptions in the operation of the miners are almost inevitable if the operator is to be protected at all times by support. Consequently, the usual practice is to advance full-face machines to the point where the operator is under or only slightly beyond the last support, whether it be bolts, posts or bars. This means that the usual advance is 18 to 20 ft, after which the machine is moved back and the newly exposed area is timbered or bolted. An alternate place or places cuts down on the loss of time if the moving distance is not too great.

If the machine is not a full-face unit, the practice is to alternate advance from one side to the other. If a full-width cut is taken on each side it sometimes is feasible to bolt one side while the other is being advanced. Adjusting length of advance to bolting time makes it possible to synchronize so that the miner operator is never out from under protected top. If the place is being cut only head width, or width-and-a-half, it usually is necessary to stop and pull back or move to another place to permit bolts or timbers to be installed.

Bolts usually are placed on 4-ft centers with continuous miners; bars on 4- to 5-ft centers, where used. If single posts are employed, they usually are set in a row or rows equally spaced from both ribs, leaving a roadway in the center. With certain types of miners recessing of bolt heads and plates into the top is being practiced at some mines to keep them from interfering when a crosscut or pillar place is started.

In pillar extraction, conventional bolting or timbering plans can be followed where pockets are driven and stumps are left against the gob for final recovery or cushion. In open-ending it may be desirable to adopt a special plan. One, for example, more suitable for full-face units, involves cribs and breaker posts to protect the open lift until extraction is completed. Another is based on bars bolted at one end and supported on a post or posts at the other—usually next to the gob. This system it will be noted, would be more adapted to ripper-head or on other non-full-face units. Or, the latter procedure might be reversed to put the posts on the solid side so that they could serve as part of a breaker installation for the next lift.

Even though support is more complicated in continuous mining, such mining has so far proved to be far safer than any other method of extraction.

Coating and Sealing

Consider for protecting certain roofs in certain areas against the adverse effects of moisture and temperature changes.

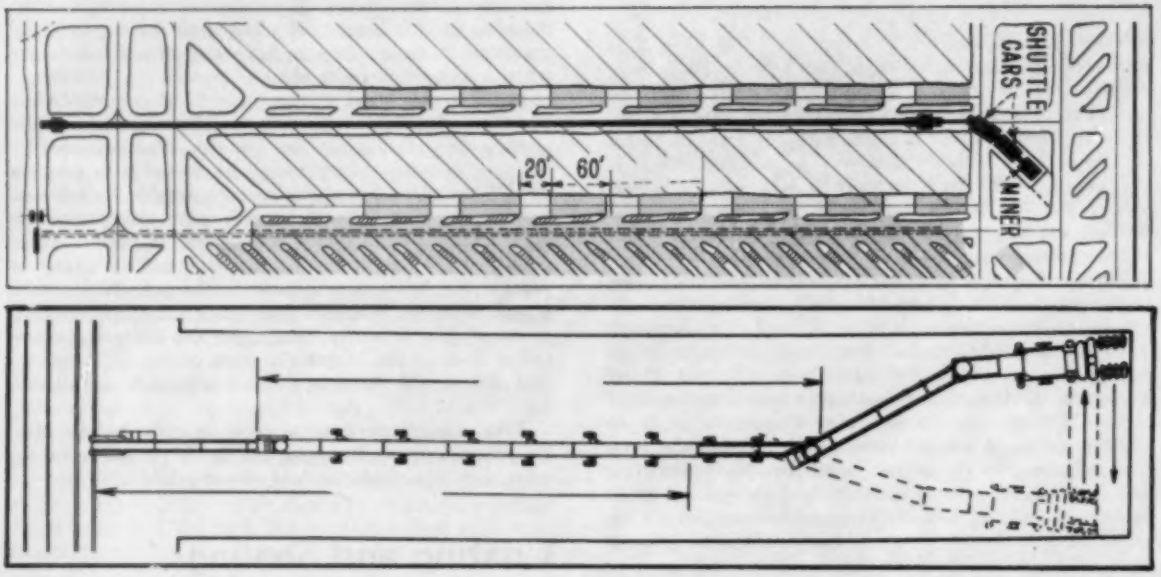
THE SUSCEPTIBILITY of certain types of roof to changes in moisture and temperature is so pronounced that a number of deep mines in the past have installed elaborate conditioning units to insure uniform humidity and temperature. More recently, even though the idea is old, a number of operators have turned to coating and sealing to prevent roof and rib deterioration as a result of these influences.

Coating and sealing products include vinyl compounds, coal-tar products and mastic-type materials—all sprayable with or without heating, usually because they are dissolved in a volatile compound which evaporates after application. Because solvents normally are flammable or explosive, or both, care must be taken in application. Also, care must be exercised to see that after application the material will at least not propagate fire even if ignition cannot be prevented. A number of products now on the market meet this standard.

Careful scaling and dryness are major prerequisites to good sealing. Though it provides no support, sealing has cleaned up some very-costly roof and rib disintegration situations at a number of mines where conventional timbering failed to do the job. Cost varies from 15¢ to 20¢ per square foot minimum at most operations, including scaling and other preparations. Usual practice is to seal the top and carry the coating 6 or 12 in down each rib for insurance. At some mines, all the coal ribs are sealed to prevent sloughing. One of the incidental benefits is a smoother surface, which helps ventilation.

Resin Injection

The usual objective of bolting, as previously noted, is binding several thin layers together to form a thicker, stronger roof beam. A new idea, still to be proved, is substituting a resin glue for bolts to bind the members together. The glue is designed to be self-setting, and is injected into the strata under pressure. Questions yet to be answered include thoroughness of penetration and the strength of the bond.



EXTENSIBLE CONVEYORS permit quick moving up and the operation of places up to 1,000 ft deep with the belt type. A plan for a rope-type extensible unit is shown at top. Bottom shows chain type setup for auger mining.

Transportation

Face Haulage 72
Trip Loading 75
Main Haulage 77
Hoisting 82
Handling Men 82

WITHOUT TRANSPORTATION it would of course be futile to try to mine coal. By the same token, good transportation results in low cost all along the line, while poor transportation is a handicap from the face right on through.

The function of transportation is to move coal from the face as fast as the loader can load it or the miner can mine it, and keep it moving to the preparation plant on the surface without interrupting loading or mining. This means that the transportation system should always be in place and ready to carry coal anytime loading is in progress. Furthermore, the system should have capacity to handle any peak the loader or miner is capable of reaching. Finally, the system should operate with a minimum of manpower and maintenance.

Face Haulage

Aim for the maximum degree of continuity by the use of continuously operating equipment or by use of the largest possible mine cars or shuttle cars, plus layouts which keep changing time to a minimum.

ALTHOUGH MINE CARS have moved into a minority status in serving face units, some of the lessons learned in attaining maximum efficiency with them apply with equal force to their successors. One lesson is use of the biggest car possible to cut down the number of changes and thus increase loading time. A second is a haulage layout providing at the best a changing point no farther back than the next crosscut, and at the worst no farther than 150 to 175 ft back. One contribution to the short change with cars was the development of prefabricated track layouts, which practically guaranteed a changing point at every crosscut.

Track condition has a real and substantial effect on car-service efficiency, not only in rooms where loading directly to cars is the practice but also even in panel-entry operation with shuttle-car or conveyor haulage in rooms. Heavy rail—up to 50- to 60-lb—is one assurance of good track in panel entries, where 40 lb is about the lightest that can be tolerated with such cars. Steel ties and prefabricated steel-tie turnouts naturally cut cost of installation and removal to a minimum.

Shuttle Cars

As with mine cars, the bigger the shuttle car, within limits set by seam and other conditions, the fewer the changes and consequently the fewer the interruptions in mining and loading at the face. Also, as with mine cars, the closer the changing point, assuming the usual two and sometimes three cars per unit, the higher the efficiency.

AC and torque-converter cars brought out in the past year not only offer advantages of simplicity and low operating and maintenance costs, but bring wide use of AC much closer. If such cars could be coupled with diesel locomotives on the mainline or, as is now the practice in a number of operations, with belts, then the change to 100% AC is rendered that much easier.

Surge Cars, Pickup Loaders—The relatively low capacity of the early continuous miners quickly brought out the fact that the intermittency of shuttle-car service, even with the best of setups, was a considerable handicap. Among the steps to offset this handicap is the establishment of storage or surge capacity between miner and shuttle car. The mine bottom is one form of storage, in turn bringing in the pickup loader. Even with the cost of the loader and operator, the increase in miner performance has been sufficient in many instances to show a handsome gain.

The surge car is a possibility under some circumstances but is not a cure-

all. The car may be a standard shuttle car or a specially built unit. Whether to use a surge car can be determined only after a careful study. Among the factors that militate against their use is large shuttle cars and a short changing distance. Also, as miner capacity increases, the situation becomes more like machine loading, where the capacity of the face unit in tons per minute is so large that some delay might be tolerated, even though it sets a dangerous precedent. If miner capacity is low, or if changing distance is long, a surge car of the right type can be a help.

Haulage Limits—The maximum length of shuttle-car haul is approximately 500 ft with two cars per face unit. The tendency, however, is to keep the maximum under 400 ft where possible because of excessive loss of miner or loader working time as room depths near their limit. This may be offset in part by introducing a third car, which, however, requires extra investment in equipment and labor, and very careful organization of the haulage system to prevent interference. However, some operators use the third car quite successfully.

The cable-reel limit can be stretched by anchoring the cable at the midpoint and backlashing on half the run. Some operators who have tried it recommend against the practice not only because the long hauls raise loader waiting time, but because backlash reeling is more difficult and is harder on cable, guides and reel. Therefore usual practice is to anchor at the discharge point. Shock-absorber-type anchorages are great cable savers, incidentally.

Though the ultimate savings at any particular operation depend upon the mining plan and conditions, the possibilities in keeping shuttle-car distances short may be substantial. For example, extra moving of transfer stations to keep distance down by 200 ft per round trip might cost, say, 1½c per ton, while the reduction in face cost as a result of higher machine output might be 10c. Separate travelways, where possible, also contribute to speeding up shuttle-car service and thus increasing face output.

Transfer to Mine Cars—In addition to rubber-tired and crawler mountings, shuttle cars now are available in four-wheel-drive-and-steer types; with right- and left-hand drives for greater convenience in operation and in anchoring and reeling cable; and with elevating discharges. The ability of the four-wheel-steer and crawler machines to negotiate 90-deg turns, incidentally, has been in part responsible for a swing away from angle development back to the old-reliable square systems. Dynamic braking is available where loads are consistently moved down substantial grades.

Unless the track is sunk, an elevator or ramp is necessary for transferring from standard shuttle cars to mine cars. Sinking is done at some mines, and normally where this is the practice an effort is made to have one station serve places in both sides of an entry. The same practice also is followed where the top must be shot to permit the use of elevators or ramps. To keep the shuttle-car haul down to the minimum, stations normally are established at intervals of 200 to 300 ft. And also to reduce top-shooting as much as possible, at least one operator has developed a low-type elevating unit mounted on a crawler-type mining machine truck (*Coal Age*, September, 1955, p 72). A high-speed conveyor is provided to eliminate slowing down or stopping shuttle-car discharge. In this instance, transfer stations are prepared by the development crews every 120 ft.

Making it possible for the shuttle car to discharge at maximum rate without stopping is, as noted, a major element in keeping an operation up to maximum efficiency. If elevator capacity is low, a hopper should be provided—usually by sinking the boot into the bottom. Or the chain should be speeded up. Provision also should be made for changing mine cars without stopping the elevator or shuttle car. Making shuttle-car and mine-car capacity match is one method being used at new mines or where cars or shuttle cars are being replaced. This method is especially effective with elevating-discharge cars, but works well with any other type of transfer equipment.

Transfer to Belts—A number of mines apparently encounter little difficulty in side loading belts from shuttle cars, but a greater number limit belt loading to end-on only, with

Trend Markers—Transportation

Torque-converter and straight AC shuttle cars cut investment and operating costs at the face and bring full AC mine operation appreciably closer.

Extensible conveyors marking up rapid gains in serving face units; and are making it possible to drive places up to 1,000 ft deep.

Automatic trip-moving and loading stations becoming more numerous.

Big cars and locomotives continue to take over in rail haulage.

Rope belts make fast start in the conveyor-haulage field.

Portal relocation increasingly practiced to cut travel time and add to efficiency in handling men and supplies.

Future Possibilities

Diesel mainline haulage to cear away the last obstacle to complete AC mining underground.

Pumping of coal from face to preparation plant.

Pneumatic or hydraulic hoisting of coal.

Case-Finder—Transportation

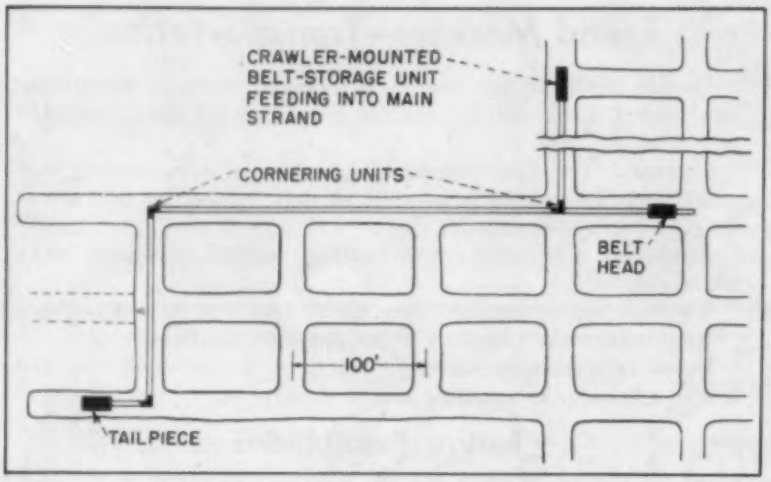
Conveyor Controls—Sequence control setup monitors belt system to eliminate delays in handling 4,000 tpd. *Coal Age*, December, 1956, p 50.

New Portal Increases Productivity—A $450,000 investment in shaft and portal building cuts travel time 54 min and increases output per man-day 1.8 tons. *Coal Age*, December, 1956, p 66.

Rope-Type Extensible Belt—Operating in rooms 525 ft deep, unit feeds to panel rope belt. *Coal Age*, February, 1957, p 108.

Belt Saddle—Easily moved unit achieves efficient transfer of coal to main belt. *Coal Age*, February, 1957, p 108.

Car Spotting—Mine-made spotter uses cutter chain with dogs to move trips and position cars. *Coal Age*, March, 1957, p 92.



CORNERING BELT PLAN provides for crawler-mounted belt-storage unit for additional flexibility and fewer stops for extensions.

usually a special hopper or a hopper-tailpiece combination to start the coal on its way. Side loading, these operators contend, results in greater spillage and, because the coal comes on at 90 deg, is harder on belts.

Where side loading is practiced, with the belt in the center of three headings, it is possible, by assigning a crosscut on each side to a shuttle car, to load at four points, provided the crosscuts are offset. Also, with two cars, one may be assigned to the end position and the other to a side position in the next crosscut down to keep them apart at all times. In end loading, with auxiliary hoppers, there is an opportunity to install a grizzly to pad the belt with fines before the lumps hit. To load belts, either side or end, a low ramp or an elevating-discharge car is necessary. A saddle-type hopper that can be moved along the conveyor (*Coal Age*, February, 1957, p 108) can help materially when it is necessary to shift side-loading stations frequently.

Unless belt speed and width are sufficient to move the coal as fast as the shuttle car can discharge, delays are bound to occur. To prevent these, and also to improve belt-loading conditions, a number of steps may be taken. One is to install a two-speed motor with automatic timing control to speed up the belt while the shuttle car is discharging and cut it back automatically afterward. Transfer conveyors capable of taking maximum shuttle-car discharge and at the same time designed to feed to the belt at the proper rate are used at a number of mines. They may be of the belt, chain or shaker type, with or without hopper and with or without two-speed controls.

Incidentally, where a number of elevators or conveyors discharge to a belt, it is possible to interlock to prevent simultaneous operation and overloading of the belt by the outby unit. One mine uses a skate wheel on a flat spring under the top run of the belt (*Coal Age*, May, 1951, p 83). When the belt is loaded, the spring is depressed to hold in a button locking out all elevators except the one in use. As soon as the belt clears, the button is released to permit another elevator to start automatically. Other suggestions are finger or paddle switches actuated by being struck by coal to prevent an elevator or a crossbelt from pouring coal onto an already loaded main belt.

Shuttle-Car Roads—Ruts, dust and mud are the major difficulties in building and maintaining shuttle-car roads. A good rut preventive used at many mines is to sling a section of light rail or angle crosswise underneather the cars and just clearing the bottom, using chain or wire rope.

Where there is much mud, planking is the usual answer, normally with 2x8's or 2x12's on stringers of the same material under the tire tracks. Spaces of, say, 3 in between planks reduce the number necessary and also provide places in which to lay cables serving other machines that might use or cross the roadway.

Tire's and Tire-Filling—Water filling of shuttle-car tires is now widely accepted, though some contend that water should not be used at shuttle-car speeds. Lately, the solid tire has challenged the pneumatic type. Advantages include longer life, higher shuttle-car travel speeds and no failures (see *Coal Age*, May 1955, p 95 for full details).

Battery Tractors

Rubber-tired trailers or trailer trains pulled by battery tractors are among the developments and modifications of the original shuttle-car idea. They were developed primarily to meet the problems of the small drift mines in coal under 36 to 40 in, with some in 24 in or less.

Before the train idea was evolved, a number of designs for a low-cost shuttle car for such operations had been developed (*Coal Age*, April, 1953, p 88; July, 1953, p 88; February, 1954, p 116; June, 1954, p 101). Built with automotive axles and certain other automotive parts, the earliest such units usually had a capacity of less than 1 ton and were designed for hand loading. The usual motive power was a single-phase repulsion-induction motor with automotive-type transmission. The trailing cable, up to 1,000 ft in length, was dragged behind the unit. In later models, capacity was increased to 3 tons to permit use behind loading machines, and DC power was employed. Also, tractors were developed for pulling bottom-dump trailers. In all instances, the units operate all the way from the face to the dump outside.

The battery tractor is used to pull up to 10 trailers (*Coal Age*, May, 1955, p 99). It acts like a gathering locomotive also functioning as a main-line haulage unit. Both three-wheeled and four-wheeled trailers with lift endgates are used, and after the tractor pulls the trip to the outside it usually backs the cars one by one to a gravity dump, though dumping is done by hand on occasion. Hauls up to ½ mi have been handled by equipment of this type.

Conveyors

Since the conveyor is designed for continuous operation it is logical to consider it for all phases of haulage, including in rooms. In addition, the conveyor can work in low seams without taking top or bottom. Therefore, it finds wide application in thin coal because of both continuity of operation and low height, particularly where hand loading is the practice. The advent of the duckbill, sawbill and similar heads also provided the further advantage of converting the shaker type into a loading machine as well as a transporting unit. And to reduce moving time and labor, at least one crawler-mounted conveyor head is now on the market.

Bridge Conveyors—Continuity of operation also made the conveyor an attractive possibility for use behind

loading machines. However, capacity in a practicable-sized unit is relatively limited, and keeping the tail boom in proper position over the conveyor is a time-consuming chore. As a result, conveyors made little headway in serving loading machines until the advent of the bridge unit. By providing a continuous and continuously functioning connection between loader and room conveyor, and by relieving the operator of all but the responsibility for keeping the machine in coal, the bridge unit has resulted in major increases in tons per man at the face. A typical bridge plan appears on p 00 of this issue.

Evolution of the bridge unit has included development of the tandem bridge. Full discussion of the use of the tandem bridge in continuous mining under a variety of conditions appears in *Coal Age*, February, 1954, p 92.

Articulated and Cascade Conveyors—Development of the continuous miner and accompanying emphasis on development of conveying mediums also has resulted in the design of articulated and cascade conveyors and conveyor systems. One version of the articulated conveyor developed for a boring-type miner consists of a series of interconnected belt conveyors on wheels, each with its own driving and propelling motors (*Coal Age*, January, 1954, p 64). It is capable of advancing up to 1,000 ft simply by propelling itself ahead as the miner proceeds. It requires, however, a place for storage of up to almost all its entire length when places are breaking away. This storage may be outside in the pit in working from the outcrop, or down the heading in driving rooms underground.

The cascade system is substantially similar, but has some differences. One is in the fact that the conveyors need not be coupled, though hitches are provided to permit the train to be pulled behind the boring unit in one remote mining system.

Extensible Conveyors

Development of the bridge unit was the first step in really bringing the conveyor into the picture as a means of serving loading machines and continuous miners. The next step was to design the room conveyor so that it could be easily extended to keep up with the face unit. The first such unit was the extensible belt, first with standard angle, channel and plate frames and more recently with the top channels replaced by wire rope. Special flexible idlers are key items with both types.

Chain-type conveyors of the extensible type are a recent offering (*Coal Age*, May, 1957, p 111). In this unit, made up of sections mounted on rubber-tired wheels, each section has a gooseneck in the middle, with the raised rear end riding on the low front end of the succeeding section. This results in an extension of approximately 50% of the length of each section.

With the bridge conveyor followed the conventional or rope-type extensible unit, a continuous conveying route is provided from the mining unit to the transfer point or main line (*Coal Age*, June, 1954, p 88; October, 1954, p 96; July, 1955, p 50; February, 1957, p 76). Advances up to 1,000 ft can be made without moving out of the place and without any other operations than adding stands and belt. Sections of belt and stands 100 ft long, permitting advances of 50 ft, usually are added in less than 5 min. Plans for taking pillars with extensible belts are included with other plans in the section on "Opening and Development," "Continuous Mining" and "Conveyor and Machine Loading."

As an example of results with extensible belts, one mine listed among the savings the elimination of six surge-car and six shuttle-car operators per working day of three shifts. Two extensible belts feeding to a panel belt were installed. Other advantages included: elimination of many mechanical and electrical delays, as well as many shuttle-car hazards resulting from hauling under steel timbers. Also, there are fewer ventilation interruptions.

Adding a 100-ft roll of belt for a 50-ft advance takes two men 3 to 5 min at this operation, while moving the complete unit out of one room and into another takes 60 min. Two section mechanics take off belt while two face timbermen and a recovery man dismantle stands and rollers and move the tail piece. The miner operator trams the head piece out and helps with dismantling. In removing belt, one section is taken off the top followed by one section on the bottom. This leaves a clean path for the men removing the stands, which are stored against the ribs (pillars are not removed) ready for use when the time comes in the next place.

The Cornering Belt—A new coal-company development permitting a belt conveyor to be turned 90 deg without breaking the belt and setting up an auxiliary drive increases the flexibility of the extensible unit and permits development of groups of places without moving the drive and transfer point.

The corning or right-angle-turn device also makes possible a system of development eliminating a number of the stoppages and time and labor involved in even the relatively few interruptions with the conventional extensible unit. As shown in the accompanying diagram, this is accomplished by means of a crawler-mounted storage section in a heading in advance of the opening in which the main belt section is placed. When the usual length of extension represented in the belt stored on the drums is exhausted, the entire crawler unit is trammed forward or backward as necessary to permit a new advance with no further operation.

In the initial entry-driving setup, the right-hand heading was used as the beltway. It was driven in 100-ft sections, or the distance between crosscut centers. After the heading was advanced 100 ft ahead of the crosscut location it was picked up and driven completely across and the third, or left-hand heading was picked up and advanced 100 ft. Then a turn was set and the center heading advanced 100 ft, after which the cycle was repeated.

Trip Loading

Set up system that will prevent delays to face units. Conduct such loading with no men, if possible, and in any event with no more than one.

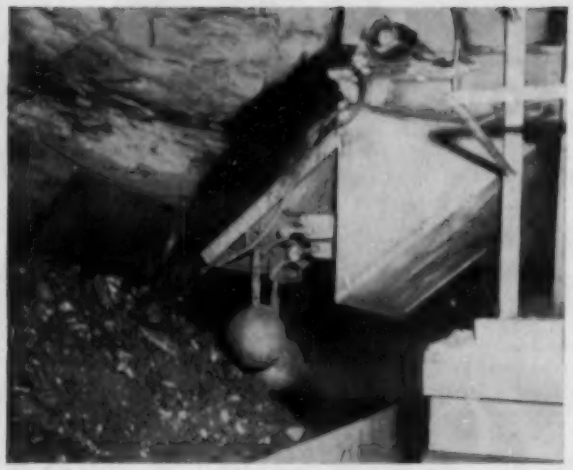
Trip Movers

Various systems and units for moving trips past loading stations, whether they be ramps, elevators, belt discharges, or what have you, include the following among others now used:

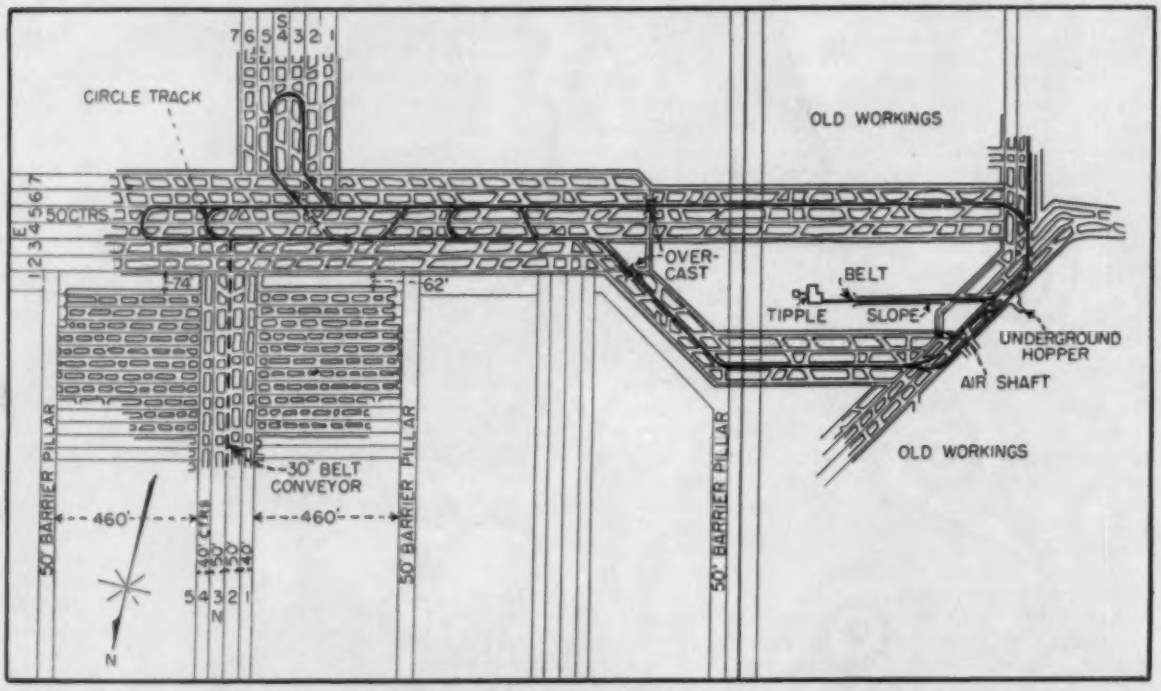
1. **Gravity**—Possible but hazardous when the usual spragging practice is followed.

2. **Gravity Retarding** — Feasible with a rope and a brake drum with manually or motor-applied brake.

3. **Operator-Controlled Locomotive**—Fairly widely employed in the past and still employed in a number of mines. Ordinarily means an extra labor cost unless the same motorman pulls to sidetrack or outside in which case care must be taken to see that the trip-changing interval is not too great. Complete looping of track, discussed more fully later in this section, facilitates this trip-moving scheme. And where locomotives pull to the outside and heavy grades are en-



AUTOMATICITY THE KEYNOTE in haulage as in other operations. Here 25-ton cars are being loaded automatically by a mother belt with the aid of overlapping cars ends aand switches actuated by rollers and ball-type floats.



TRIP-LOADING PLAN illustrated above involves circle tracks around the beltheads, permitting locomotives to move trips continuously without storing empties. The loop is completed at the slope bottom.

countered, a few operators put locomotives both in front and behind trips both with loop track and with conventional layouts to achieve uninterrupted haulage .

4. Remotely Controlled Locomotive—Machine with brake set up as required and with the controller on the first point, on separate section of wire which is energized to move locomotive and trip by switch operated by boomman or attendant.

5. Remotely Controlled Trip-Spotting Hoist—Sometimes accompanied by smaller hoist to pull rope back for coupling to fresh trip.

6. Barney, Chain-Feeder and Ram-Type Between-the-Rails Spotters—Newest in the line of trip-moving equipment, these units are positive and accurate in operation and permit designing transfer stations for maximum efficiency in trip changing. The changing function can be preset or controlled by limit switches for precision and also for automatic performance if desired. Also such equipment lends itself to operation by shuttle-car drivers, and thus, even if not made automatic, requires no special attendants.

Track Layouts

The simplest form of track layout for car or trip loading is the tail-track system. The track can merely be extended down the heading, or it can be turned right or left, as shown in an accompanying plan, or it may be turned right or left and then turned back U-fashion in an adjacent head-

ing. The major disadvantage is that trips must come out the same way they go in, meaning increased loss of time unless the changing track is very close.

Sidetrack or loop-track systems provide access from both ends, and thus permit the quickest-possible trip changes, with no time loss at all if properly set up. The sidetrack—if that is the system—may be in the same heading as the main track. More usually, however, it is in an adjacent heading. Or the sidetrack may, in effect, be made continuous by tracking the second heading and installing chutes and crossovers at intervals. Double tracking represents some extra expense but does result in greater flexibility and more assurance of quickest-possible trip changes.

Automatic Loading

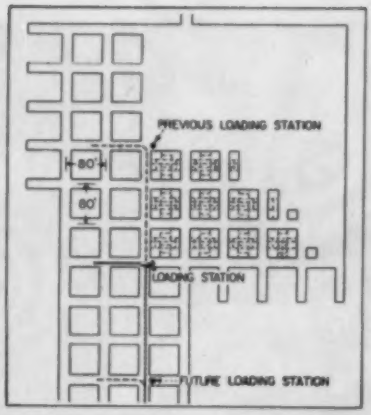
Complete loading of trips without any operators or attendants whatever already has been achieved in coal mining (*Coal Age*, August, 1953, p 99). Late-type underground stations (*Coal Age*, March, 1955, p 66; January, 1956, p 70) include facilities for automatically diverting the coal from one car to another, controlling the hoist moving the trip, and starting and stopping the belts. Even cars off the track are provided for.

Switching Coal

The problem of switching coal flow one car to the next in continuous trip loading can be met in a number of ways. One is the overlapping mine car (*Coal Age*, January, 1956, p 70) or articulated trip in which facilities to bridge the gap are built onto the cars. Thus, there is no need to stop either conveyor or elevator, or trip, during loading.

Where the coal flow is not too great, means of preventing spillage during car change include a simple plate or chute to catch coal while changing is in progress. When the new car is in position, the plate is tilted by the boomman and then is slid around on the top edge of the car to its next position. A new wrinkle in equipment of this type is a plate with holes at one end to accommodate hooks suspended from the top. As the car moves ahead, the hooks hold the plate and eventually tilt and dump it into the next car.

Heavier flows of coal, as off a mother belt, usually require power or some other type of equipment for a quick change. Power equipment includes the short reversible conveyor mounted transversely under the head of the main belt. Equipment without power includes a "pants chute" with flop gate to divert the coal stream from one car to the next.



SIMPLEST TRIP LOADING is tail track, turned 90 deg through crosscut.

Main Haulage

Use big cars and high-capacity locomotives for minimum haulage cost.

Provide track that will permit high-speed operation with a minimum of maintenance.

Consider belts for main and secondary haulage, especially the latter.

WHATEVER ITS TYPE, the goals in main haulage are (1) ample capacity with operation scheduled to prevent any interruption of loading or mining at the face, and (2) operation with minimum manpower and equipment.

Rail Haulage

One-Stage or Multistage?—Main haulage usually is in two stages, relay and main-line, with a few operations dividing it into relay, secondary and main. There is a disposition, however, to question whether multistage operation should be adopted automatically. One-stage operation requires heavy track to the belt head or other loading station, but the extra cost may be much more than offset by decreased haulage labor and maintenance costs. The possible savings warrant careful study of the question before the system is finally settled upon, or an existing relay system is continued.

Cars and Locomotives — Even though cars are less and less taken to the face, where size has an appreciable effect on loading-machine productivity, capacity still is an important factor even in main-line service. One argument for the biggest possible car is that it costs relatively less to buy big cars than small cars. A second is that the big car holds more coal per pound of car weight, and therefore less dead metal has to be dragged around for the same coal delivery.

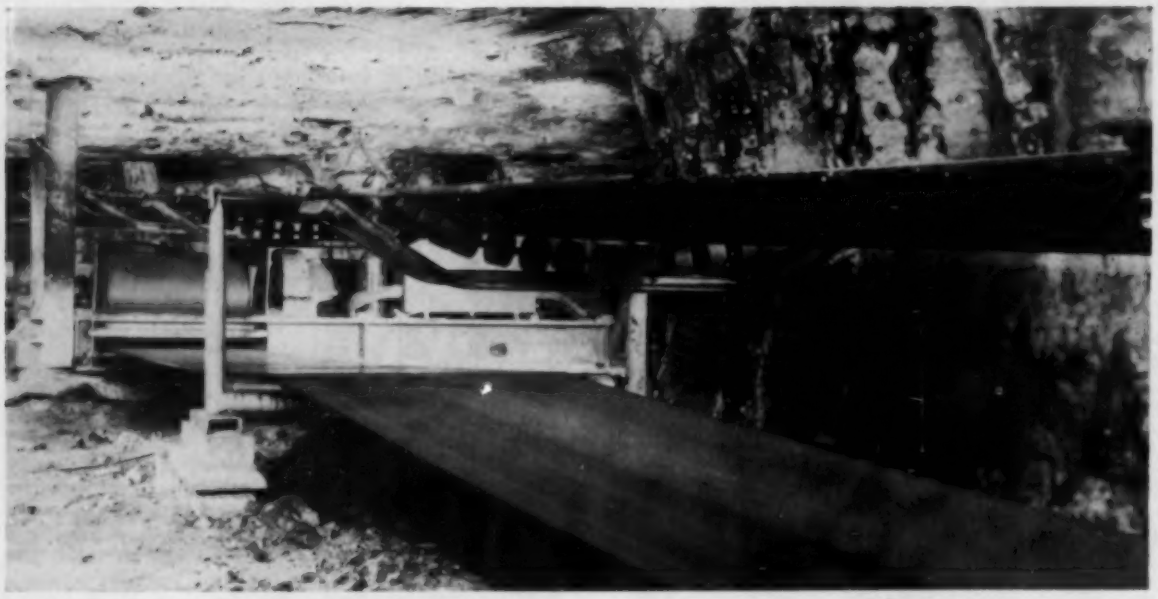
In the case of locomotives, if one big one can replace two smaller ones, there is an obvious saving in labor. Or two smaller units can be made into a tandem job to get the same saving. In at least one instance also, three small machines were tripled into a single 12-mph unit with spectacular savings (*Coal Age*, September, 1952, p 76). Accompanied by reconstruction of the haulageway and the installation of big cars, the triple-header was delivering 4,500 tons over a 4½-mi haul with two men, compared to 4 and sometimes 5 locomotives and 8 to 10 men for 3,500 tons previously. More recently, a single 50-ton machine capable of pulling 1,600 tons on a straight, level track (*Coal Age*, January, 1954, p 111) has gone into service.

Other examples of changes to bigger cars and locomotives include replacement of 2¾-ton wood cars with 13-ton steel units and the installation of new high-capacity high-speed locomotives at one property. New dumping facilities and rebuilding of the main haulage road rounded out the program. The two new locomotives replaced five smaller units and motor crews were cut to one man, releasing about 55 men to other jobs and cutting haulage cost about 75%.

Aids to safety, efficient operation and low maintenance in car design include:

1. **Automatic couplers.**
2. **Spring draft and buffing gear.**
3. **Antifriction - bearing wheels.** With high speeds and swivel trucks, as in 8-wheel designs, wheel metal and treatment becomes a more critical problem. Answers include special mixtures and chilling with cast iron, and cast or forged steel.
4. **Lightweight corrosion-resisting materials.** Newest is aluminum plate, shapes and extrusions for maximum weight reduction. Another form of construction for simplicity and strength with minimum weight is the use of standard structural shapes—for example, channels for sides and ends on low-vein cars.

Antifriction bearings also mark the modern locomotive, which, especially in main-line service, tends toward a higher rated speed, usually 12 to 15 mph, with certain types rated up to 35 to 40 mph. Modern electrical con-



NEW ENTRY in the underground transportation field is this rope-belt conveyor, featuring a truck-mounted drive unit operating up to 100 ft away from the discharge pulley. Faster belt moves are a big advantage.

trols include provision for dynamic braking where grades warrant. For absolute reliability in such braking, a 32 v battery permits continued operation even when trolley power fails.

Track

Generally accepted standards for good main-line track include 70- to 90-lb rail on heavy treated ties laid in crushed slag, gravel or cinder ballast. The importance of treated ties is shown by one study indicating total tie costs for 1 mi of track for 20 yr as follows: treated ties, $10,600; untreated ties, $34,000.

Welding has come sharply to the fore as a means of joining rails, with steel arc the most widely employed. Curves should have a radius of 300 to 500 ft and should be superelevated. Turnouts should not be less than Nos. 5 to 8. Trolley wire should be hung at a uniform height above the rail and aligned with it at the proper distance outside. Shoe-type collectors should be used where feasible, especially on heavy-duty locomotives, and the trolley wire should be adequately lubricated at the proper time intervals for low maintenance and efficient current collection.

Throws and switch-position indicators are essential for safe, smooth main-line haulage, while alloy frogs and proper guarding keep down maintenance and reduce derailments. Automatic switchthrowers and remotely actuated derails save labor and promote safety.

Double Track or Single?—Most authorities agree that double track is for the big mines, though they split on what is "big." Advantages of double tracking include complete separation and no interference between empty and loaded haulage. Also, since waiting at sidetracks and passing tracks is eliminated, fewer cars and locomotives are required. Furthermore, one track usually always is available and therefore production seldom if ever is completely interrupted. In addition, some mining men point out, double tracking where grades are heavy makes it unnecessary to use a tail locomotive, which might otherwise be considered desirable. Also, it permits installing spring-type derails on upgrades.

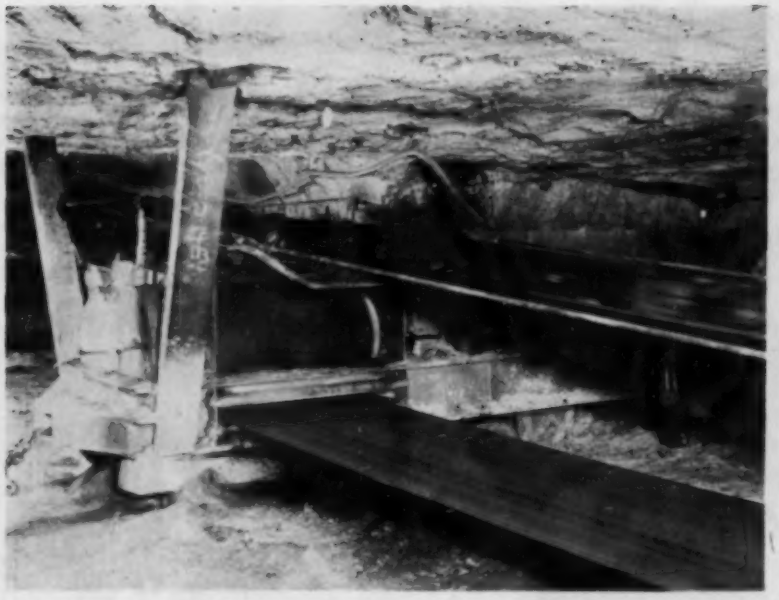
Almost the equivalent of double tracking can be attained by proper location of properly designed passing tracks, though where several locomotives normally pull to the bottom it might be desirable to double track that portion of the main line handling, say, 75% of the mine tonnage. An alternative is a marshalling yard at the point where all the tonnage, or most of it, comes together, with a single-track single-locomotive stretch to the portal, and single track with passing tracks inby the yard, perhaps supplemented by some double track.

Use of locomotives on both ends of trips may have an advantage other than safety. At one mine this practice also makes it unnecessary to run locomotives around trips, either at the panels or at the main dump (drop-bottom cars). Sections are equipped with looped loading tracks and hydraulic car spotters. The haulage crews, one for each of the two locomotives, change trips at the loading points.

Drainage—Mud and water can reduce the capacity of a haulage system as much as one-third or more. Proper ditching is a major answer to keeping haulage roads dry. If gravity disposal is impossible, sumps should be constructed to receive the water and facilitate disposal by pumping. The importance certain mines ascribe to dry haulage roads is attested by a program of building cisterns in crosscuts at strategic points and equipping these with automatically controlled pumps discharging to an outside line. Incidentally, mine water may also be diverted for sprinkling at the face since it has to be handled anyhow and might as well be bled out of the main discharge system.

Grading—Eliminating humps and hollows not only makes for smoother, safer haulage but also can result in a significant saving in number of locomotives and crews necessary for a given tonnage. If possible, sustained grades against the loads of over 1¼ or 1½% should be avoided. If averages higher than that cannot be avoided, then it is even more essential to knock off peaks.

One problem is synchronizing grading and main-line extension with face advance to permit the latter to go



DRIVE UNIT of new belt operates from truck which is anchored in position in tracked crosscut. Unit can be moved in 4 manshifts.

ahead efficiently while at the same time providing enough open length so that a proper profile can be arrived at. In most instances, a stretch of 1,000 to 1,500 ft is necessary to fix the profile and thus determine where and how much grading must be done. Two suggestions for providing this distance are: (1) use a belt conveyor in advancing the entry, or (2) lay light track in a side heading to serve while advancing the headings and bringing up the heavy steel. If it is felt that the investment in a belt for this limited use is high, track is a lower-cost alternative, though not quite as convenient.

Track Cleaning—Smoother, faster haulage, less track deterioration and greater safety are the major reasons for emphasis on clean track. Track-cleaning machines naturally reduce the cost to a minimum, while cars in good condition reduce spillage and stretch out the intervals between cleaning. In many instances, a considerable tonnage of good coal is reclaimed in the cleaning process, which might well be credited against cleaning cost. Some mines, as a matter of fact, figure they are well ahead of the game by salvaging coal off the track.

Lighting—Safety, speed of operation and maintenance all are facilitated by good lighting of haulage roads. The latest types of units are flourescent tubes, which provide a significant increase in light output for the same current. For a discussion of fluorescent lighting in working sections, and of incandescent lighting along haulage roads, see *Coal Age*, February, 1956, p 84.

Incandescent lamps were the original light source, with the usual spacing as 75 to 100 ft. With the usual wattage of lamps, this normally is sufficient to comply with the rule that there should be no dark spots between lamps. Glare elimination requires proper location, and if necessary, shielding. Mounting lamps along one rib, rather than in the center, may help in glare reduction.

To save power and lengthen lamp life it is possible to sectionalize lighting systems and equip each section with trolley actuated switches so that only those lamps in front of the trip burn and then only until the trip passes through the section. Of course, locomotives should be equipped with the best in headlights.

Haulage Control

Except where the haulage system is of the simplest type, the dispatcher is essential not only for efficiency in haulage but also as a means of keeping a finger on conditions and progress throughout the operation for the benefit of the foreman and superintendent. In his business, he uses not only the regular telephone but, along with other mine personnel, the carrier-current phone—on locomotives and cages as well as in offices and stationary communication posts throughout the mine.

Ready communication with locomotive operators is the great advantage of the carrier-current instrument, the use of which some mine managers have stated has raised output and efficiency 10% or more. For better coverage of key points at a practicable cost, at least one mine (*Coal Age*, December, 1954, p 67) has supplemented carrier-current equipment with "loudspeaking telephones." These are tied in with the carrier-current system, including the locomotives, and are provided with auxiliary battery power to permit communication if the power goes off. As an example of how the units extend communication range, it is now easy for the boomman at the belt discharge, for example, to talk to the shuttlecar operators feeding to the belt, as well as to the locomotive operators and outside stations.

Block signals at times can take over in part or completely in control of haulage, aside from their other major function of preventing interference and collisions. Normally, however, in the control area, they supplement and round out the dispatching program, making it, in the experience of many mines, more accurate and efficient.

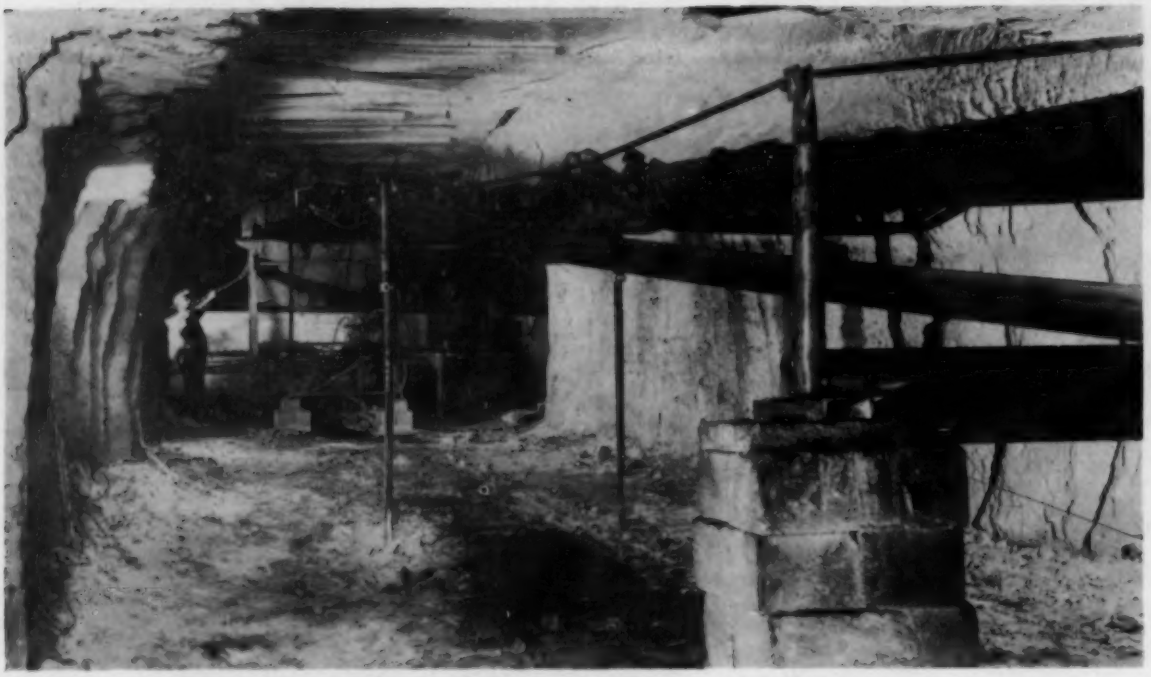
Belt Haulage

Because of the increased difficulty and cost of setting up and maintaining an efficient track haulage system in thin coal where top or bottom must be taken, the belt conveyor, with a few exceptions, first made its mark in underground transportation in low-vein operations. It was of particular benefit in eliminating brushing and providing continuity of transportation in panel haulage, which normally aggregates several times main-line haulage over the life of the property, and was a natural complement of conveyor transportation in rooms. Since that time the belt also has moved into thick-coal mines for both main-line and panel service.

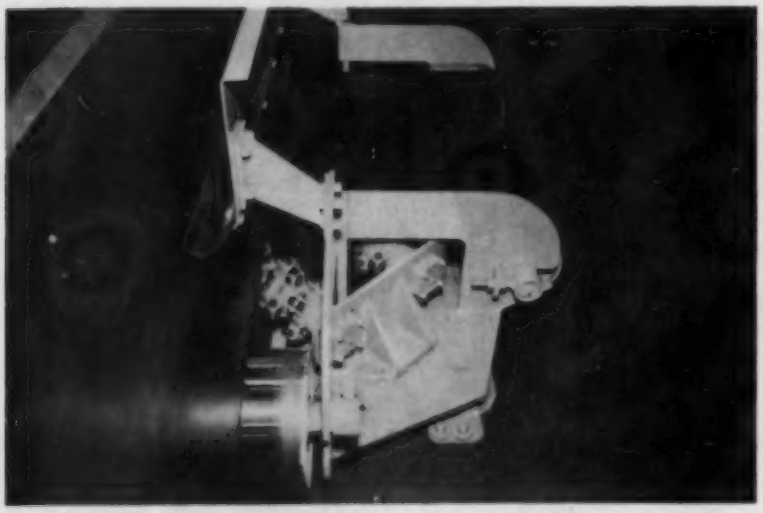
The reasons for one belt installation in thick coal, where the output will aggregate 1,000 tph, include the following:

1. Less manpower in building up and maintaining rated tonnage.
2. Less routine deadwork (brushing, grading, timbering, etc.) in establishing and maintaining haulage.
3. Fewer haulage delays, with consequent increase in face productivity.
4. Fewer haulage accidents.
5. Greater concentration of production with greater overall efficiency.

In this installation, a separate rail system for handling men and supplies



DRIVE UNIT TRUCK of portable-head conveyor is out of picture to the right. The belt discharges at left into mine cars where automatic loading controls swing flopgate to prevent spillage between cars.



CORNERING DEVICE permits 90-deg turns in a single belt conveyor to keep continuous transportation up close to face machines.

was installed, with the result, according to operating management, that men and supplies are handled more efficiently while at the same time there is no possibility of interfering with coal haulage.

Rope Belts—Reducing the weight, bulk and complications of the conveyor structure has of course been the goal of the designer since the first belt conveyor went into service. The need is especially great in the thinner coal where the belt has some added advantages.

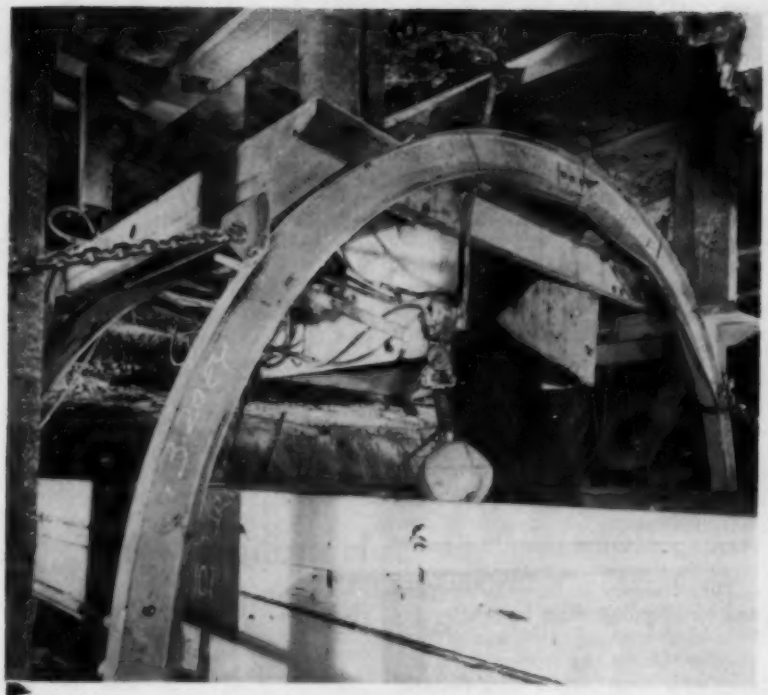
Conveyor sections have been progressively lightened and redesigned for quick assembly and disassembly. The use of a wire rope as the carrying member for the top-strand idlers is the latest step toward simplification and reduction of weight and bulk. Among other advantages, there is a major saving in installation time even though the same care is taken —as it should be—with alignment and other installation requirements. Compared to the conveyor structure of 20 yr, which today involves a labor cost of 55½c per foot at one operation, the cost of extending the rope-belt conveyor is only 11c per foot.

Portable Belt Heads—A new development with the rope-belt conveyor is the portable belt head. The first such unit was designed for 2,000-ft-long 36-in mother units specifically designed to receive coal from shuttle cars and discharge into large mine cars. The basic elements are common to most conveyors but the arrangment makes the difference.

The drive section, including motor, controller and power-transmission facilities, is mounted as a complete unit on a rail truck. To move it into position, it is trammed to a spot in the first crosscut inby the main line, which means that the drive is 60 to 100 ft from the belt discharge. The drive stays on the truck, which is anchored in place while remaining on the rail.

The discharge pulley, together with a flopgate chute, are integral parts of a knock-down arch unit which is set up to straddle the main-line track. The arch, flopgate chute and pulley assembly are hauled to the site on a mine car. The arch then is set up and the two-way chute and pulley mounted in place.

Wire ropes are then attached to



ARCH UNIT, straddling main line track, supports discharge pulley, flopgate chute and other equipment of portable-head belt.

the arch and are strung out along the entry, passing over the drive. Two or three adjustable supports are used to hold the rope between the discharge and the drive. The remainder of the conveyor is the standard rope-type unit.

The latest move involved shifting the entire 2,000-ft-long unit from one entry to another and setting it up ready for use. Total labor required was less than 4 man-shifts. In contrast, the usual requirements for the conventional rope belt was 30 man-shifts or more.

Belt Operation

One secret of efficiency in main-line belt haulage is proper installation according to the recommendations of the conveyor and belt manufacturer. Another is the employment of one man properly trained and equipped to patrol service and lubricate each 1½ to 2 mi of belt line. A third is proper loading of the belt. Chutes should turn the coal in the direction of the belt, lay down a cushion of fines and, if possible, put the coal on the belt at the same speed. In a few high-tonnage systems, short speedup belts are used to turn coal from panel belts and deposit it on the main-line units in the right direction and at the right speed. Thus, the punishment is largely confined to the speedup unit. Big lumps, incidentally, require a wider belt, a heavier carcass and proper covers. Cushion idlers at transfer points are essential in helping protect the belts. Good splicing is a must.

The most effective method of determining motor and/or belt overloading, particularly with panel belts, is reading the motor current with a tongtype or other meter. Stuck idlers, piled up loose coal rubbing on the belt, and belt rubbing against the frame are common causes of motor overloading. Another, in addition to piling on too much coal, is too much belt for the grades encountered.

Fire Protection—Measures to prevent ignition and retard fire propagation include, in addition those of an electrical nature, the following:

1. Use of neoprene, which also improves troughing and lengthens life.

2. Preventing or protecting against drive-pulley slippage, including automatic counterweighted takeup and devices to stop the motor when the belt slows down or stalls for any reason.

3. Preventing stuck idlers by proper lubrication and service, supplemented by good housekeeping to eliminate material that might be ignited.

4. Following proper inspection and maintenance methods to eliminate rubbing of belt against the frame.

5. Removing electric cables and other possible sources of ignition to parallel openings.

6. Preventing coal spillage and dust accumulation, plus periodic cleanup of belt structure and beltway.

7. Providing adequate communication between strategic points along the system for quick reporting of trouble.

8. Providing rock dust supplies at intervals for fire-fighting.

9. Providing fire doors for control of smoke and for ventilation in case of a fire.

10. Providing water in ample quantities.

11. Providing fire extinguishers at beltheads and transfer points and keeping them in good operating condition.

12. Establishing ventilation to limit volume to a minimum consonant with effective ventilation, and to prevent rapid spread and the passing of smoke and fumes to the active working sections.

13. Providing an escapeway on intake air for any personnel caught inby a fire in the belt entry.

Electrical Protection — Suggestions for electrical control and protection include:

1. Connecting each drive to the line through a stepped resistance.

2. Sequence starting, outby drive first, with proper time delay for each subsequent drive.

3. Automatic stopping of all inby conveyors or elevators if any belt should stop for any reason. The usual device is a centrifugal switch.

4. Interlocking conveyors or elevators feeding to a belt to prevent feeding onto one already full loaded. Devices include finger- or paddle-actuated switches, as well as the skate-wheel spring contact-maker described on p 74 of this section.

5. Providing overload or pileup protection at belt transfers, using paddles or other devices to actuate switches and shut down the inby drive. These switches should be of the momentary-contact-type so that the inby conveyor will start again when the overload is cleared.

6. Providing a means of stopping the conveyor anywhere along its length to permit the beltman or any man riding to stop the belt at any time. Continuous pullcord type controls fastened to the roof also provide protection against falls.

7. Providing drive-pulley slippage control to stop the unit as soon as slippage occurs. A centrifugal switch with pulley riding on the belt, or a centrifugal switch driven by a chain from the bend or snub pulley, are

two possible devices. A third is a differential control with two pulleys, one riding the belt and the other the drive pulley so that when one gets out of step the drive is stopped.

Belt Cleaning—A number of devices, each more or less satisfactory, have been developed for cleaning belts before they go onto the return idlers. A recent one apparently coming closest to the ideal is a length of piano wire mounted under the head pulley and almost touching the belt (*Coal Age*, November, 1952, p 89).

Detecting Belt Tears—One of the few practicable methods of detecting major tears in operating belts has been developed at a middle western mine (*Coal Age*, January, 1956, p 88). It consists of a horizontal rod 2 in in front of the head pulley. When struck by a torn flap thrown out from the belt by centrifugal force, the rod is knocked down to open an electrical switch and stop the belt until it receives attention.

Hoisting

Use slope belts where possible and consider special high-strength conveyor belts for long-length slopes and high lifts to down number of drives and transfers.

Make shaft hoisting and auxiliary operations as nearly automatic as possible.

IN THE ABSENCE of special circumstances, the belt slope is the usual coal-hoisting facility installed today. Low operating labor and low maintenance are the major reasons, while improvements in belt design, including rayon, nylon and steel-cord tension elements, have made it possible to install single belt runs up to 3,000 ft or more in hoisting, thus raising the vertical lift to more than 800 ft.

The British-developed cable belt is a possible new contender in hoisting service, with one installation over 3,000 ft long in service in Canada. In the ordinary belt, much of the carcass weight and thickness represents strength in tension to permit the load to be moved without pulling the belt apart. In the cable belt, the pulling is done by wire ropes, one on each side and independent of the belt. Shoes incorporated in the belt, or more recently a grooved edge molded onto the belt, rest on the ropes and provide enough friction for pulling the belt and the load along.

Belts also work equally well in lowering coal where the terrain permits their installation at inclinations of under approximately 20 deg. Other facilities for lowering include monitors and rope-and-button conveyors and so on.

Any of the standard types of dumps may be employed in transferring coal from mine cars to the belt, unless bottom-dump cars are employed. If so a necessary intermediary is a hopper or bin. Where belts are used for main-line haulage, boomed shuttle belts are used to lay the coal down in a longer and therefore larger-capacity bin. Short transfer and speedup belts also are used between hoppers and slope belts to take the shock and protect the slope unit from some of the wear and tear. Magnetic tramp-iron-detection equipment on either the speedup or main slope belt stops the equipment and permits removal of metal that might result in damage.

The tendency is to make hoppers and bins feeding slope belts of a size to hold at least 15 to 30 min of production. Unless, as frequently is the case with drop-bottom cars, the trip is pulled through the dump by the locomotive, power trip feeders and trip makers should be employed for efficient car handling. Properly placed and operated sprays keep dust within reasonable limits. An alternative is a hood and duct system with collectors either above- or below-ground. In some instances, trip feeding, dumping and trip making are completely automatic by virtue of the necessary starting, stopping and limiting switches.

Belts may be and are used in hoisting between levels, or from the face to the surface where seam pitch is not over 18 to 20 deg. Above that, some form of rope hoist is required. It usually is a single straight drum powered by an AC motor. Lowering is made more efficient and smoother by installing DC dynamic braking.

Shaft Hoisting

The skip hoist usually raises the equivalent of 2 or 3 cars each trip and thus normally can operate more slowly, with lower acceleration peaks. Where self-dumping cages are employed, fabricating them of high-strength alloys or aluminum reduces dead weight and consequently improves the hoisting operation. Where platform-type cages are employed, the British have developed the "container" idea to speed up hoisting and materially reduce labor. In this system, the coal is dumped into hoppers from which it is chuted alternately into two containers with bottom doors on which regular flanged wheels are mounted. As a container is filled a ram shoves it onto the cage, moving the empty container off for refilling. At the top, the process is reversed, and the container is dumped automatically by permitting the bottom door to swing down.

As with all other mining operations, economy in hoisting is a matter of equipment and controls to conserve manpower. Now, any type of vertical hoist—skip, self-dumping or overturning cage, and platform—can be made completely automatic, including caging and, with platform equipment, decaging. Even if complete automatic operation is not desired, automatic cagers, tripmakers and the like speed up the hoisting process and save labor.

Handling Men

Keep travel distance short by building new man-and-materials portals at the necessary intervals.

Use transportation equipment and methods that provide the maximum in safety with the maximum in time-saving.

IN THESE PIPING portal-to-portal days, a major consideration in designing facilities for handling men is keeping travel time to a minimum. As an example, if actual working time is 6¼ hr, or 375 min, increasing it 15 min is equivalent to producing the same tonnage with 1/25th fewer men. Greater time savings enhance the benefits and increase the limit of expenditures to secure them. At an average of 6 mph for a man trip, if permitted by law or regulations, cutting the distance 2 mi saves 40 min per man in production time.

Portal relocation, among other things, provides an opportunity for streamlining the handling of men and also attaining maximum convenience and comfort in changing in and out. A collateral benefit is an up-to-date field supply setup, with possibly also a field maintenance shop that is much nearer the active workings. Aside from supplies and maintenance, key objectives in portal design include:

Ample all-weather parking.

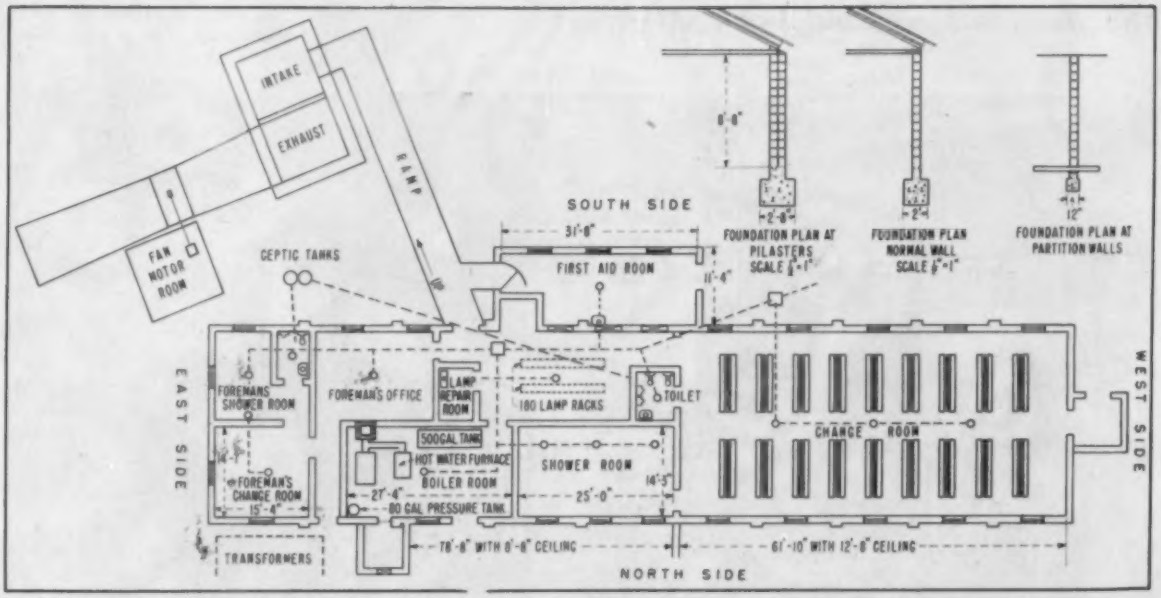
Good wash and change facilities.

Good lamphandling facilities.

Protected facilities for men waiting to board trips—from weather and electricity particularly.

Adequate first-aid facilities.

As an example of the possibilities of portal relocation, one mine, for an investment of $450,000 in a shaft and portal building, cut 54 min off



NEW PORTAL BUILDING cutting 54 min off travel time provide for comfort and convenience of employees and supervisors. Ample parking space and a service station are provided near the building.

the travel time and raised output per man-day 1.8 tons (*Coal Age*, December, 1956, p 66).

Hoisting

Where men are handled through separate man-and-material shafts, either at the main opening or back at field portals, usual practice today is to install pushbutton-operated elevator-type equipment in capacities up to 50 men, which reduces the total time required to put a crew into the mine car or bring it out. The cage may also be adapted to handling heavy supply items, though the tendency is to use the regular opening for this purpose, especially if it is a drift or slope.

Drilled shafts with automatic hoists may provide a lower-cost answer to the problem of putting portals close to the working areas. At one mine (*Coal Age*, November, 1955, p 60) a 72-in drilled shaft was fitted with a double-deck circular cage with a capacity of 10 men per deck. Pushbuttons control the automatic hoist. Hoisting distance is 487 ft. Travel time was cut 45 min with a resultant rise in output.

Where men enter through slopes, some mines, where the regular equipment cannot be employed, provide special slope cars for that part of the trip. If single cars are employed, the trend today is to equip them with magnetic track brakes actuated by an overspeed device or by a pushbutton under the control of a foreman or triprider. Where several cars are put together in a trip, they can be preceded by a pilot car with magnetic-brake equipment. If men walk the slope, a "ski-tow" installation, which gives them a one-handed pull, is a major help in negotiating the stairs in the "up" direction.

Car Transportation

Where height is sufficient, the covered mantrip car is practically standard for transporting men by rail. In addition to cars pulled by locomotives self-powered units are available in capacities up to full section crews, making it unnecessary to detach locomotives for this service. Where several individual cars are in service, dispatching and block signals are essential to prevent collisions. At trackless mines, corresponding equipment on rubber, and with battery power, is available.

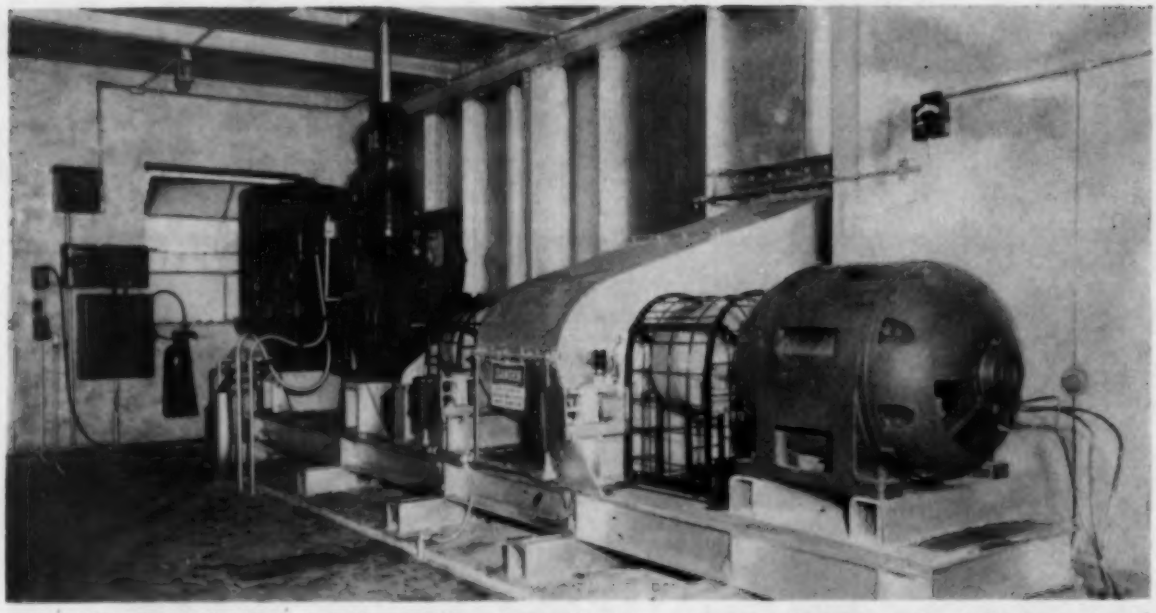
Low coal makes it more difficult to cover cars that go into areas where top is not taken. Flat-bed rail cars with rubber mats can be used, with the men lying crossways. Self-propelled types include one in which the men lie down with knees up to each end (*Coal Age*, March, 1954, p 190). Capacity is sufficient for a section crew of 11 men. Height over the rails is 24 in. As in thick coal, equivalent equipment is available on rubber for thin-coal operations.

In addition to regular mantrip cars, a variety of rail and rubber-mounted cars may be employed to save time and promote efficiency in transporting mechanics, electricians and repairmen, as well as officials. The list includes even small one-man three-wheeled "trikes" for trackless operations. Types for mechanics, electricians and repairmen include tool and supply boxes and wells or decks for carrying heavy items.

Belt Transportation

Under proper safeguards, movement of men on belts has proved both safe and efficient. The major safeguards include ample vertical clearance all the way, extra clearance at points where men get on and especially where they get off, equipment to reduce speed to approximately 200 to 250 fpm, and an emergency stop cord or stop system all along the belt so that any man can stop it at any time. The system should be designed so that the belt cannot be restarted without a check to see that no hazard is involved. A space of at least 6 ft must be maintained between each man on a belt.

Belts may be reversed to take men in, and a few mines have designed mainline systems with that in view. In going in, men necessarily must get off and change if more than one belt is in service. There also should be a rigid rule that men get off and change coming out as well. Ample clearance and smooth unencumbered footing should be provided at all loading and unloading points. Finally, in addition to all other steps, no movement of men on belts should be permitted except while a responsible supervisor is present.



THE BEST IN MODERN FAN EQUIPMENT, with standby drive to insure continuous operation, is the heart of good ventilation when mine and fan are matched. Well-planned coursing of the resulting air current creates good working environment and saves power.

Ventilation

Basic Principles . . . . . p 84
Ventilating Equipment . . . p 85
Lower Power Costs . . . . . p 87
Splitting and Regulating . . . . . p 88
Bleeder Headings . . . . . p 89

THE RAW ELEMENTS of mine ventilation are these: That some device or method be employed to create a pressure differential at some point in the air circuit; and, that the air which is caused to flow as a result of the pressure differential be coursed through the circuit in an efficient and economical manner. With all eventualities accounted for, the result will be an environment in which men can work comfortably and effectively and in which harmful gases will be diluted and removed with least trouble.

But accounting for the eventualities is sum and substance of practical mine ventilation. The pressure differential must be of such magnitude that the desired quantity of air will flow against the resistance offered by the airways. This resistance must be kept to a practical minimum to control the power consumption which creates the pressure differential. The air current should be split to provide safer ventilation in various areas, and this introduces a need for regulation to insure a balanced system.

Furthermore, decisions must be made as to whether worked-out areas should be sealed or ventilated. If the decision is in favor of ventilating these areas, a system of bleeder entries will have to be worked out. On top of all this, the entire system must be patrolled, inspected and maintained because a coal-mine ventilation system grows longer and possibly more complex every working day.

These fundamentals apply in planning ventilation for a new mine or in revamping or maintaining the system at an existing property. Taking the latter case, because high-cost ventilation is more of a problem at mines already opened up and more or less advanced in years, any effort to improve, modify or update a ventilating system must be based upon accurate pressure and velocity surveys. Regions of high resistance or excessive velocity must be identified, and the extent of wasteful leakage must be determined. Having this information to guide him, the ventilating engineer may then select the places where his investments in time and money will be most rewarded.

Basic Principles

Control excessive velocity by looking for opportunities to get one-way flow which releases additional airways for intake service.

Consider the advantages of methane drainage through boreholes ahead of the actual recovery operation.

MOST OF THE EFFORT is put forth with one eye on the power bill, since the goal is to provide adequate ventilation at minimum power. And following back from the power bill,

it is seen that keeping the velocity of the air within reasonable limits is a basic requirement because (1) power varies as the cube of the velocity; (2) pressure varies as the square of the velocity, and (3) quantity varies directly with velocity.

A change in any of these conditions naturally forces a change in all others since all are interdependent. Furthermore, existing conditions at a particular mine, lumped together in the term equivalent orifice, finally determine the magnitude of the ventilating job.

But it is possible to change or control the conditions which determine the ventilating job. For example, doubling the number of airways to carry the same quantity reduces the velocity by half and the total power required by three fourths. Similar improvements in varying degree may be achieved by cleaning up airways to reduce resistance, sealing leakage, splitting and regulating in the most efficient manner, shortening the distance of air travel through the use of new airshafts and other such steps.

Even at mines where the ventilating duty is governed by the amount of methane made in the workings and the necessity of diluting it and sweeping it away, there is the possibility of draining off some of the methane through boreholes tapping the solid coal ahead of the mining. Thus it may be possible to ventilate at reduced velocity or with less volume.

A full account of how one company conducts these surveys and the benefits that accrue is contained in the June, 1956, issue of *Coal Age*, beginning on p. 68. One of the major benefits is that the ventilating system has the capacity to accommodate future expansion of the mine. Other savings include: (1) elimination of the need for a 400-ft airshaft, (2) elimination of a need for additional airways and (3) possibility of ventilating increased area without speeding up the fan.

Such savings result from performing the cleanup and improvement indicated as necessary by the survey.

Ventilating Equipment

Mine and fan should be matched because both fan efficiency and the characteristics of the mine enter into total ventilation efficiency.

Ohm's Law applies in flow of fluids also. Keep in mind the analogy between electricity and air flow when faced with ventilation problems.

Trend Markers—Ventilation

Simplified, lower-cost main ventilation results at new mines developed for 100% continuous methods and using roof bolting. Quantity requirements are scaled up but concentrated production eases air handling.

Although overall mine ventilation may be simplified, new emphasis is placed on getting effective face ventilation, especially over continuous mining machines.

Bleeder openings adopted at many new mines to give positive knowledge of conditions in job areas by permitting all-round inspection.

In multiple-entry systems in gassy mines air is brought up center headings, split both ways across faces and returned through outer headings.

Future Possibilities

Automatic systems for continuous methane detection are now under study for possible future application, including even provisions for interrupting power when methane content exceeds predetermined limit.

Integral dust collectors on face machines, particularly continuous miners, are in the research and development stage.

Case-Finder—Ventilation

Carefully supervised auxiliary fan improves visibility, provides greater quantity at face in continuous-mining development section. *Coal Age*, February, 1955, p 88.

Lightweight boring machine drills ventilation raises in pitching seams. *Coal Age*, August, 1955, p 58.

Taking the action indicated by a complete ventilation survey eliminates need for a new airshaft, saves cost of driving new airways, makes it possible to ventilate larger area without speeding fan. *Coal Age*, June, 1956, p 68.

Ventilation and dust-control with continuous miners—The problems; what is being done to meet them, and what is needed for future progress. *Coal Age*, July, 1956, p 56.

Bleeder-entry effectiveness—Five plans and their results, as analyzed by USBM. Conclusion: effective if properly planned and kept clear. *Coal Age*, December, 1956, p 70.

Ventilating continuous-mining sections prescribes a high volume of air passing over the machine and moving toward the gob. *Coal Age*, March, 1957, p 60.

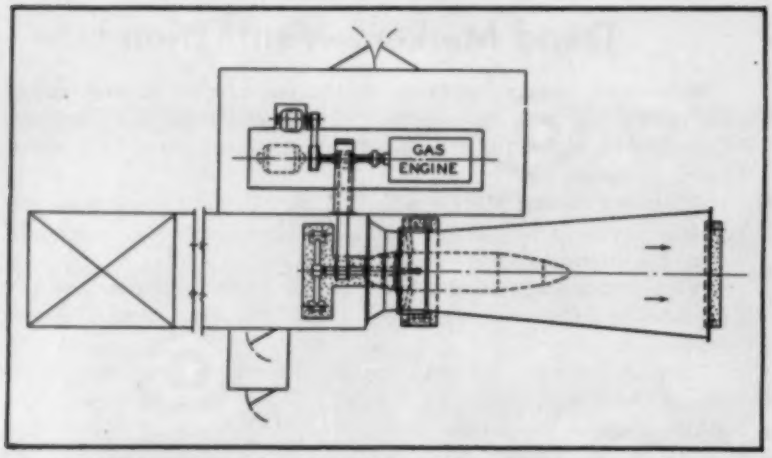
Reducing dust and gas problems in continuous mining requires that more attention be paid to face ventilation in these high-speed operations. *Coal Age*, May, 1957, p. 73.

LATE-TYPE FANS, with few alterations in mine conditions, often can effect substantial reductions in power consumption, partly because of the inherently higher efficiency of the new units and partly because the new fans can be more closely matched to mine characteristics. Quick blade adjustment makes it relatively easy to keep mine and fan more closely mated.

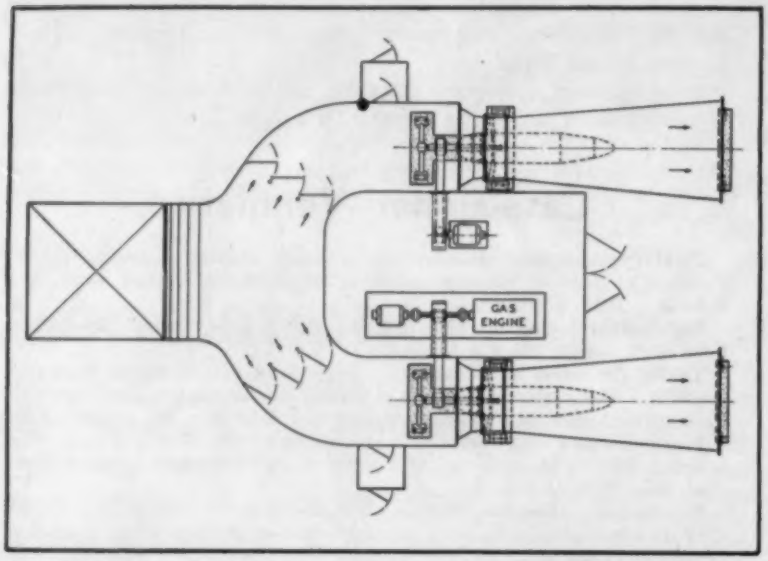
Dependability in fan service can be assured through the use of auxiliary drives—a gasoline engine, for example—in standby service. A recent refinement in control for outlying fans employs carrier-current equipment (see *Coal Age*, October, 1955, p. 68) for both signalling and control.

Better design in ventilating materials is not confined to fans alone. Also available are improved curtain materials, including treated cloth and neoprene-coated types. Spad drivers have been developed to reduce materially the time required to install line curtains and checks.

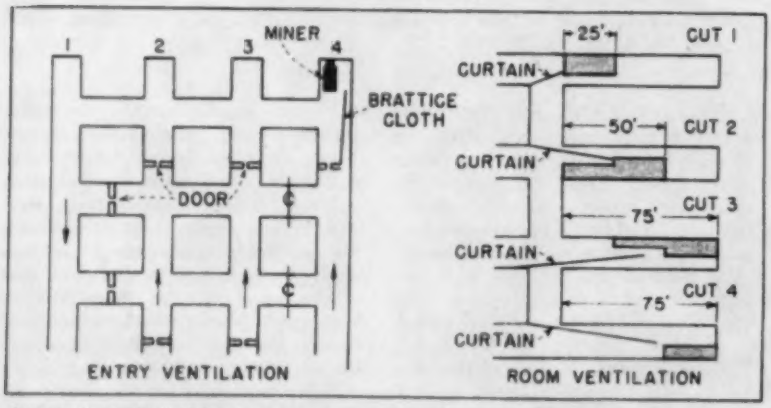
New materials for stoppings include telescoping metal sections, sheet plywood and plastic sheeting, as well



SMALL-MOTOR DRIVE through V-belt may be replaced by larger direct-drive motor as mine-ventilation needs grow. Note standby engine.



PARALLEL FAN SETUP features standby drive on one fan for continuous operation during power failures. Engine starts automatically.



FACE VENTILATION in gassy mines demands strict line-curtain discipline to conduct fresh air right up to the cutting elements of the miner.

as inflatable stoppings. Big features in both of these are rapid installation for savings in labor and full reclamation for savings in supply costs. Other materials include concrete blocks, also reusable in many instances, and sprayable coatings for sealing against leakage.

Prefabricated materials, corrugated pipe sections for example, may be used to construct air bridges, thus cutting the cost of such construction and permitting the use of more overcasts to the exclusion of doors and other wasteful air-current controls. As a result of these developments, overcast is no longer a bad word in designing ventilation systems. They are used more and more in modern mines as the best means of dumping used air into the returns with least ado or of initiating splits.

Auxiliary air movers, including fans and portable evase units for the control of compressed air, may be of some help when properly used with the approval of regulatory agencies. Better ventilation in continuous-mining has been achieved through the use of auxiliary exhaust fans and flexible tubing. Installed with safeguards against recirculation, the fan provides adequate air at a velocity which is sufficient to remove dusts to an appreciable degree, improve visibility at the face and dissipate the heat generated by the face equipment. Improvement of these fans is a matter now receiving intensive study in the industry.

A brand new starter that bears study in continuous mining applications is a wet-type inertial dust collector in a small package that holds promise of moving air over these machines and efficiently collecting dust in one operation. A description of the unit appears in the Equipment News department of *Coal Age*, July, 1957.

In anthracite, trumpet-shaped air movers, connected to compressed-air lines, have been used to direct air to the faces of steeply-pitching places beyond the last open cross-heading.

Doors are a necessity at some point in every system. Recent developments in these include a new compressed-air-powered automatic door for heavily-traveled haulageways. The operating controls are actuated through the trolley system and all mechanical linkage and the operating cylinder are suspended from the mine roof and attached to the top of the door. None of the parts are exposed to wet bottom conditions nor to damage from possible derailments. Some mines now swing their conventional doors from steel jacks to make possible faster relocations.

BETTER FACE VENTILATION for faster advances today require tight, well-built line curtains. Use spad drivers, as shown above, to get anchorage where other means of suspension are not available. Curtain is wired to roof channels at right.

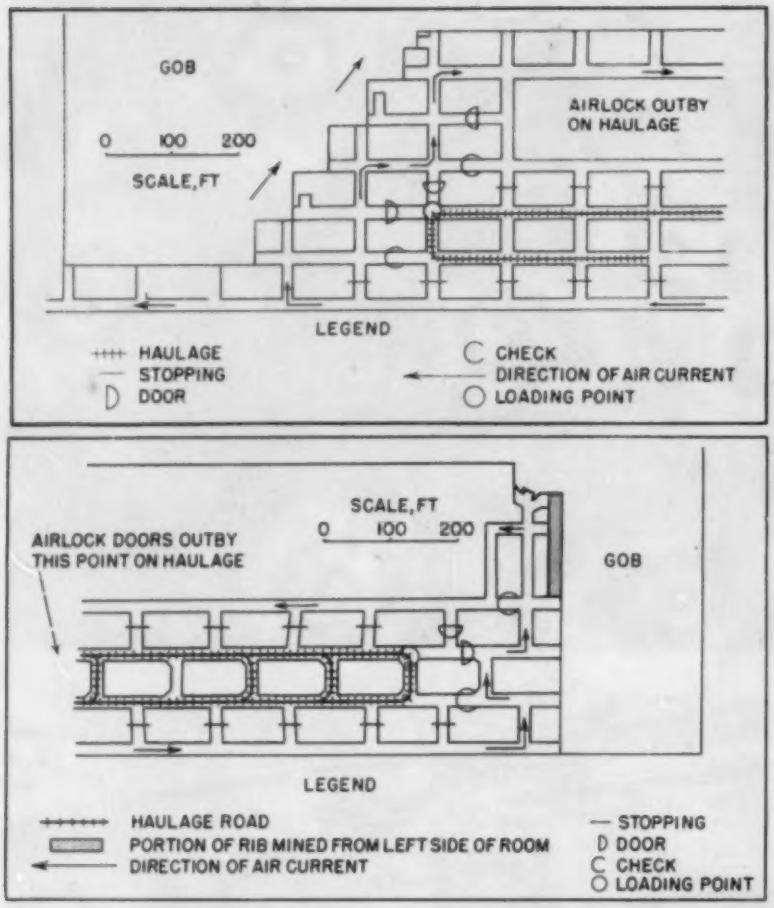
Lower Power Costs

Providing ventilation is one of the most expensive elements on the cost sheet. Good planning can reduce the cost of power, the most expensive item in total ventilation costs.

Choose one of several new drilling techniques to provide low-cost auxiliary ventilation openings.

THE ADVANTAGES to be found in modern ventilating equipment may be fully realized or they may remain undeveloped, depending upon the degree of care and skill employed in conducting the air through the workings. Excessive leakage and insufficient airway area are especially wasteful, no matter how efficient the fan.

Fugitive air is the most expensive luxury in today's coal mines—and the most dispensable. Surveys of some mines show that up to 80% of the air moving through the fan never reaches the working faces. It leaks through poor stoppings, around doors and so on, back into the returns without moving anywhere near the active sections. Even in mines where ventilation is given more serious consideration leakage may short-circuit up to 30% and more of the incoming air.



TWO PLANS for achieving good face ventilation in block system (top) designed for continuous mining and in room work (bottom).

The penalties in fugitive air, measured in terms of wasted power, border on the tragic. Since a certain quantity at the face is mandatory, fan speed must be increased to insure that effective face ventilation, over and above leakage, will meet these legal requirements. And power consumption increases as the cube, while the increased velocity contributes to still more leakage.

Sealing at points of excessive leakage is one way to lick the problem. Another and better way is to look for ways to achieve one-way flow, thus eliminating leakage opportunities by doing away with side-by-side intakes and returns separated by porous stoppings and other leaky control devices. Airshafts or openings to the outcrop may be used as new fan locations or additional intake openings to get the one-way flow. Even in deep cover, the cost of a new shaft may be more than recovered in a reasonable time in power savings alone.

Furthermore, the cost of sinking a shaft is not what it used to be. In one instance (*Coal Age*, April 1955, p 74), a shaft was sunk by drilling a circle of large-diameter holes with an overburden drill, then shooting the hard core against the relief provided by the drillholes. The job was quickly done with fewer men and in greater safety.

In another instance (*Coal Age*, November 1955, p 60), a shaft was sunk using a new type core drill which cuts a 75-in hole at rates of 4 ft per hr in limestone and 1 ft per hr in sandstone.

In another area where numerous wants and faults occur, it is found that a pressure system is best in ventilating long narrow gassy areas of coal so long as bleeder shafts are provided at the extremities of these coal areas. As soon as the limits of these areas are determined by completion of development work, a bleeder shaft is drilled down to the coal to remove the gas-laden air from the pillaring sections. Loose ground through which the bleeder shaft is to be drilled is consolidated by grouting. Then a 36- to 48-in hole is Calyx-drilled to make the bleeder shaft. The cost of drilling such a 36-in hole was $99.95 per ft, and a 48-in hole, $127.00 per ft.

One-way travel contributes to even bigger power savings inasmuch as a change to this system results in increased airway area with former returns now serving as intakes. The upshot is either reduced velocity for the same quantity or higher quantity at the same velocity, a bonus either way.

Splitting and Regulating

Give forethought in production planning to the effects on ventilation. It may be possible to balance production areas to reduce the amount of regulation required.

INCREASED SAFETY is by all odds the big reason for splitting air currents underground. An explosion in a mine ventilated by one continuous current of air could affect the entire mine, while in a mine served by several splits the effects would be more confined.

There are other good reasons for splitting. The mine resistance is reduced, power is conserved, and better local control of the air becomes possible. Best practice in splitting requires that the splits be separated near the point of intake of the main current and rejoined near the point of final discharge from the mine to fully realize this improved control.

The ideal situation, which shows all split naturally balanced in resistance, is seldom achieved in actual practice, since in some splits development work will predominate and, in others, room work. Some regulation becomes necessary to raise the resistance of all other splits to that of the longest or high-resistance split. Up to a point regulation is helpful, but it can become wasteful.

It pays to investigate the possibility of using an auxiliary fan to serve the high-resistance split alone, thus eliminating any need for adding resistance in the other splits. The benefits are reduced power requirements and lower pressure differentials on stoppings outby the booster fan.

Sometimes a well-planned cleanup in the free split may result in the passage of more air, also reducing the need for added regulation in all

other splits. Some companies have found a ventilation bonanza by rehabilitating old airways with roof-bolt support in place of timbers. The resulting increased area and decreased resistance work together in compounding the benefits.

Bleeder Headings

Use check curtains to keep air moving along pillar lines, through the gob and into bleeder openings.

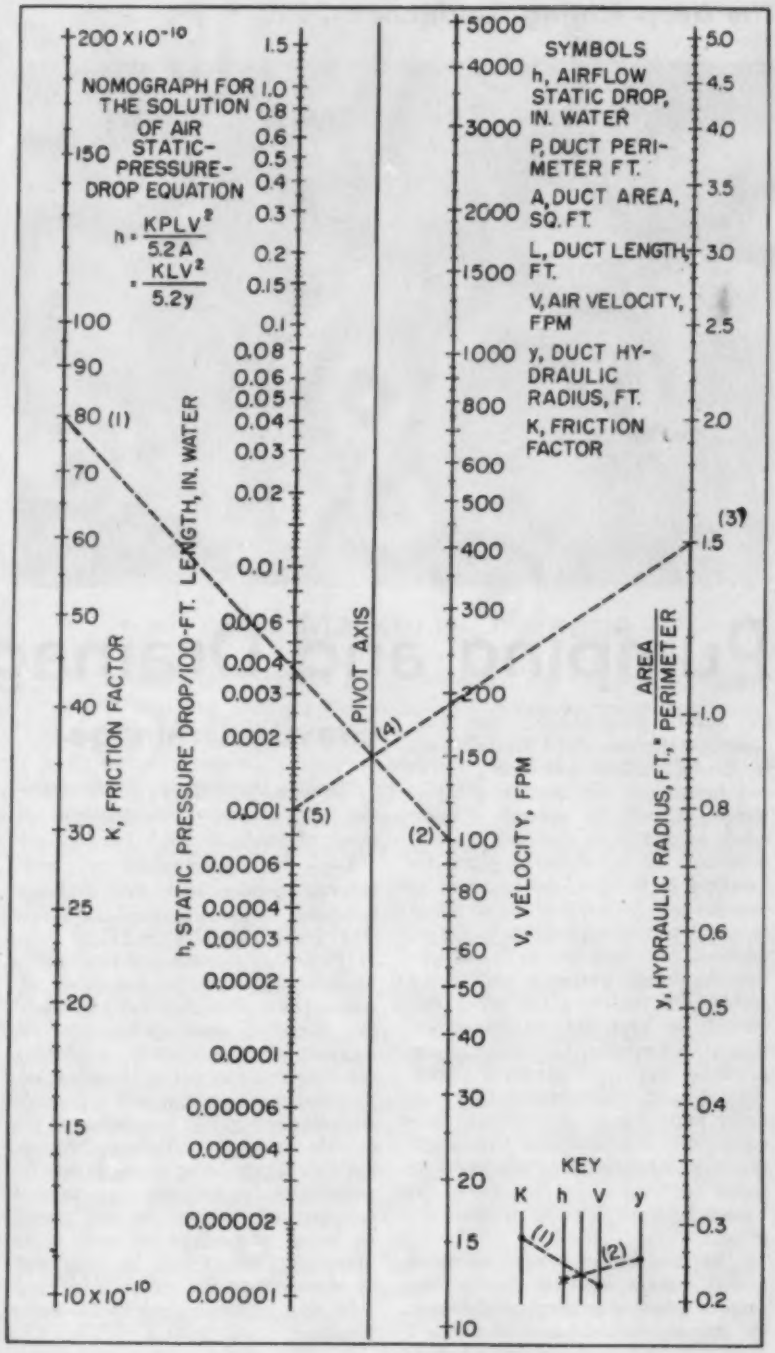
Decisions to seal or ventilate gob areas must be based on thorough study of local conditions, but recent development plans show bleeder systems becoming more popular.

ACCUMULATIONS OF GAS in worked-out areas are especially hazardous in today's coal mines because of the rapid extraction in highly mechanized methods and the consequent increase in the rate of methane emission. The worked-out area increases rapidly, close by the active places where a number of electric-powered machines are concentrated and the entire crew is assembled.

In conditions like these, more and more operators are including bleeders in their mine projections to ring gob areas with openings through which air passing through the gob may be conducted directly to the returns. In some instances, air from the worked-out areas passes into the returns through regulators which control the quantity of air passing through the gob as well as insuring adequate air and positive pressure along the pillar line. Properly maintained bleeder headings practically eliminate the possibility of gas migration through seals or otherwise during periods of low atmospheric pressure.

Along similar lines, it is advantageous in gassy conditions to begin recovery of room panels by driving a pair of line rooms along the outby limit of the panels parallel to the mains. Such rooms serve as an extra pair of low-cost airways, and the outby room may be preserved in the bleeder network after the panel has been robbed.

Specialized designs for ventilation may become necessary when a change to continuous mining is in the works; particularly if methane is a problem. At one mine (*Coal Age*, February 1956, p 88), the problem was handled by designing a bleeder-entry system to serve pillar areas and by setting up effective line-curtain techniques for use at active faces, as shown in two of the accompanying illustrations.



Determining Static Pressure Drop in Airways

Given the following: $K = 80 \times 10^{-10}$; $V = 100$ fpm; $y = 1.5$ (area divided by perimeter); $L = 3000$ ft. Determine h, drop per 100 ft in inches of water.

Procedure:

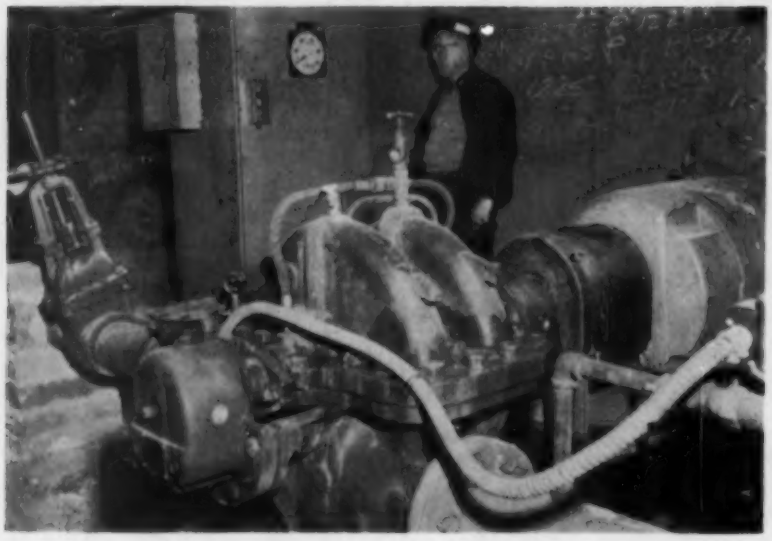
(1) Place rule on 80 on the K scale at left.

(2) Also on 100 on the V scale at right center, and draw line intersecting pivot axis, center.

(3) Place rule on 1.5 on the y scale at right.

(4) Also on pivot axis, center, and draw line to intersect h scale, left of center.

(5) Read answer .00103 at final point of intersection.



Gravity Drainage . . . . . p 90

Pump Selection . . . . . p 90

Planning Water Lines . . . p 91

Drainage Systems . . . . . p 93

Cutting Drainage Costs . p 93

AUTOMATIC CONTROLS, including positive control of priming water, make it possible to operate with minimum of attendance. Periodic maintenance checks keep the system operating to provide trouble-free water removal.

Pumping and Drainage

IN MOST INSTANCES the coal-mine operator can add a third element to the old adage concerning death and taxes, and the third element is water. It will be present at most mines in quantities that will make it necessary to lay detailed plans for handling it. In brief, the best way to proceed is to keep out of the workings as much water as possible, using the methods described later in this article, then to design pumping and piping systems for removing the water that cannot be kept out by economical diversion methods. Gravity drainage must be employed wherever opportunities exist, and operators and engineers must constantly evaluate new equipment and materials that might possibly increase the efficiency of water handling or cut the cost of the service labor required to maintain the system.

Diversion ditches around openings, sealed stream beds at troublesome points, grouting underground to seal off stream channels, new channels if necessary and well-constructed dams are possible controls which may be used to keep water out of underground workings. Flumes make it possible to conduct surface water pervious areas of mining properties and dump it back into natural drainage channels on the other side. In round numbers, it comes down to this: For each 35 gpm diverted around a 100-ft-deep mine, a horsepower's worth of pumping capacity can be eliminated.

Gravity Drainage

Planning openings for gravity drainage also can result in gradients in favor of loads in track haulage.

Look for opportunities to create outcrop openings or to drill drainage boreholes to lower worked-out areas.

IT IS neither possible nor practicable in most instances to keep out all water. Some provisions must be made for handling underground inflow. Again it becomes a matter of seeking the cheapest way out of the situation, and that means taking fullest possible advantage of gravity flow, either to the outside or to a well-planned sump.

Other things being equal, it may be possible to lay out the mine so that workings advance to the rise, giving an assist to haulage as well as to drainage. Siphons may be employed in transporting the water over local rolls, thus continuing power-less water handling.

In other instances, it may be possible to drill boreholes to the cropline or into a sump area to permit gravity flow by the most direct path. At one mine, where some places necessarily are advanced to the dip, 2-in boreholes are drilled at the face through 60 ft bottom rock to old workings in the seam below. The old workings are open to the outcrop, facilitating gravity drainage of both seams. This, too, is a possibility not to be overlooked.

At a new mine, where the seam dips 8%, room panels are worked to the dip from strike entries on advance and up the pitch on retreat. The idea is that the dip workings are finished before extensive areas have been opened up, and the dip rooms will serve as sumps for the uphill workings.

When all's said and done, however, chances are some pumping will have to be done. But handling water with today's equipment is a far cry from the difficult job it was in the past. Today's advantages include efficient pumps for any type of duty, electric power in place of steam, automatic controls to cut the cost of operation and materials designed for long life at reasonable cost.

The basis of good drainage is a well-engineered plan, of course, first making full use of surface-water diversion and gravity-flow channels, then turning to pumping installations.

Pump Selection

Use single-stage pumps in series if solids are present to an appreciable extent in the water to be handled.

Select pump materials on the basis of a complete water analysis.

THE TYPE OF PUMP selected depends entirely upon the pumping job to be done. In two out of three of today's mine-drainage applications, centrifugals of one type or another

will be found, but each of these is practically a tailor-made unit. The pumping job at one mine may be entirely different from that of its nearest neighboring mine with regard to such factors as volume, total head and water acidity. The best bet, therefore, is to work closely with a pump manufacturer in determining the one best pump for the application.

The final selection will depend upon whether the service is to be continuous or intermittent, whether AC or DC power is to be used, how much water is to be handled, how much variation may be expected in suction and discharge heads and so on. Corrosion- or abrasion-resistance may be the determining factor, and the manufacturer will have to know this before he can recommend a pump. Numerous special-purpose units are available, including even a pump operated by a belt driven by a conveyor-belt idler.

For example, if the water is free of solids, a multistage centrifugal unit to work against a high head may be used, but if solids are present a number of single-stage units in series should be used because solids ruin multistage pumps. Thus pump selection becomes an exercise in balancing a number of sometimes-conflicting factors. Complete foreknowledge of the conditions under which the pump is to work is vital to successful selection.

Also important in selection is a decision as to whether the total pumping capacity should be provided in a single unit or in twins, with the latter choice getting the nod in most recent installations because of the resulting flexibility.

Foresight should be used in arranging the pumping schedule to dovetail with operations. For example, at a three-shift mine it may be desirable to provide "peakless" pumping to spread the pumping load over the entire day, while at a two-shift mine it might be better to provide enough capacity to handle all the water on the off shift when demands for production power are at a minimum. In either case, sump capacity will have to be planned and provided to suit the system finally selected.

And in certain special cases, it would be well to investigate the possibility of "community" systems among several mines or companies. These would eliminate the waste of rehandling the same water at one property after another.

In addition, it becomes increasingly important that all possible steps be taken to move water out of the workings quickly to reduce the time of exposure of water to pollutants.

IMPROVED DRILLING enhances the value of pump-and-borehole combinations as drainage medium. This installation serves power and drainage needs.

Trend Markers—Drainage

Better drilling methods and equipment, for surface or underground drilling lead to wider use of borehole-and-pump combinations for more economical mine drainage.

Automatic control of pumps reduces need for attendants, thus reducing service-labor costs.

Cooperative pumping stations, supported by more than one company, eliminate rehandling of water at one property after another.

Case-Finder—Pumping and Drainage

Aluminum Pipe—Weight- and labor-saving features. *Coal Age*, July, 1956, p 74.

Water Neutralization—Automatic lime feeder neutralizes water in strip-pit sump before discharge to settling pond prior to drainage to streams. *Coal Age*, February, 1957, p 101.

Acid Control—New approach involves getting water out of the mine immediately through boreholes to reduce sulfur pickup. *Coal Age*, March, 1957, p 68.

Dual-Purpose Borehole—4-in pump line installed in same hole with four 2-in pipes for power cables. *Coal Age*, June, 1957, p 70.

Planning Water Lines

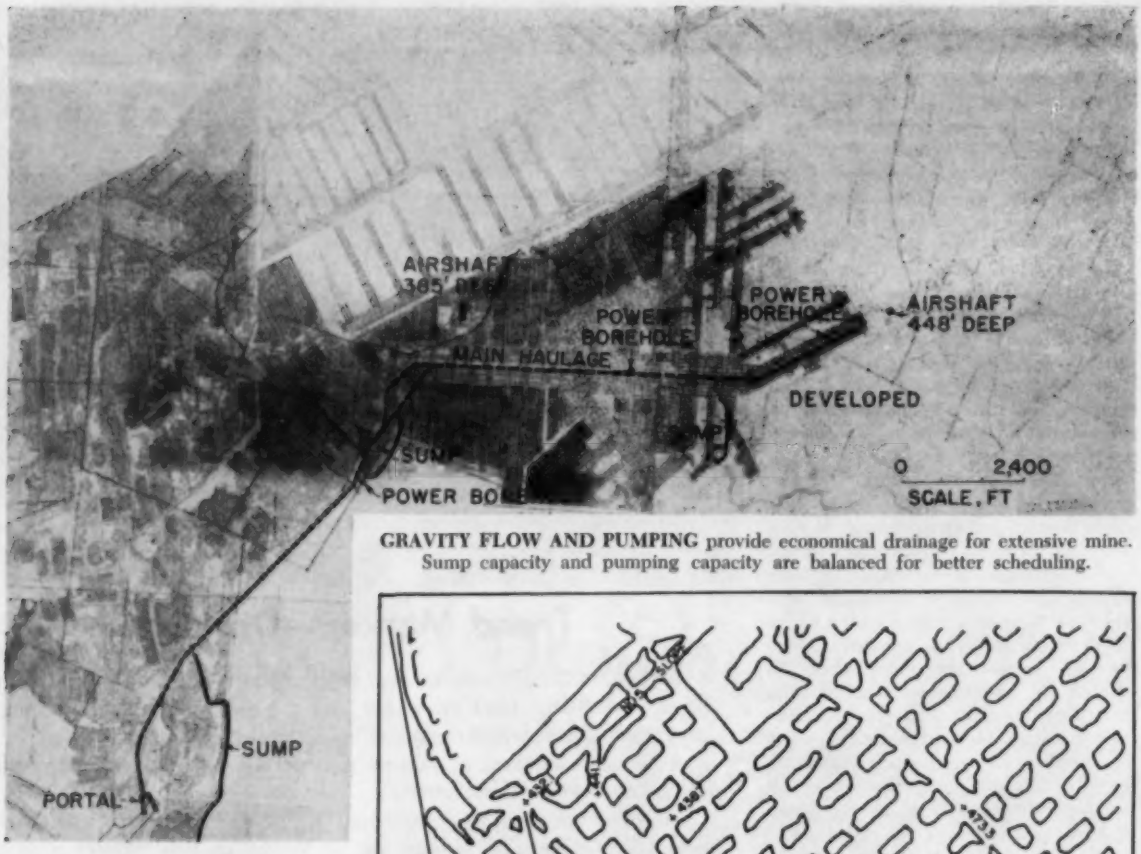
Eliminate fittings and sharp bends wherever possible to keep line friction to a minimum.

Don't overlook the need for lining or sealing underground ditches in multiple-seam mines to keep water from leaking to lower workings.

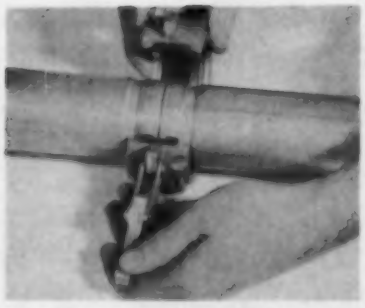
THE BEST PUMP in the world can be limited by a poorly-designed piping system. What are some of the factors to be considered in system design?

Usually the major variable which is amenable to some measure of control is the friction head in the piping itself. The quantity to be pumped is a definite figure and the static head is fairly fixed, but the friction head can be held to a minimum by designing for the largest-diameter straightest pipeline it is possible to achieve. Small pipe and numerous fittings and turns will extract a penalty in the form of either higher power requirements or reduced volume of discharge.

A standard 90-deg elbow for 6-in pipe is equivalent in friction tendencies to 16 ft of straight pipe, for

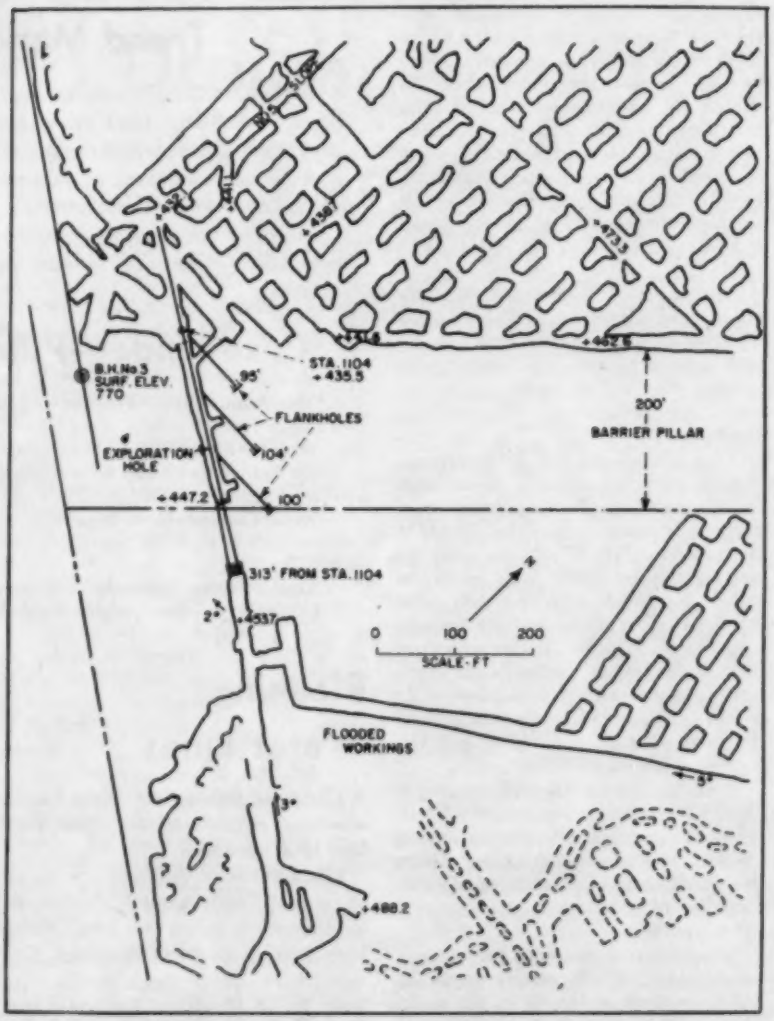


GRAVITY FLOW AND PUMPING provide economical drainage for extensive mine. Sump capacity and pumping capacity are balanced for better scheduling.



FAST-ACTION COUPLINGS mean greater lengths of pipe installed per day.

LIGHTWEIGHT PIPE, lasts longer, requires less labor for installation.



HORIZONTAL BOREHOLES, another drainage possibility, permit flooded workings to be unwatered through lines in active mine.

example, and an open globe valve in the same line is equivalent to 160 ft of straight pipe. The reason for using a minimum of fittings is obvious. Tables showing straight-pipe friction equivalents of various fittings are found in a number of handbooks and should be used in pipeline layout.

In the normal case, pipe of the largest usable diameter will be most economical in the long run. With the length of the piping system and the number of fittings known, it will usually work out that the combined costs of piping, pump and power will be lower with large pipe.

A well-designed pump installation will show these features:

- The suction line leads straight into the pump for a length equal to four to six pipe diameters.
- The section pipe is one or two sizes larger than the pump nozzle, and it is connected to the pump through an eccentric reducer which is properly placed to eliminate suction-line air pockets.
- The drive motor and pump are in good alignment.
- The piping is supported so that the pump carries none of the pipeline weight.
- Priming auxiliaries, if they are needed, and lubricating facilities are in good working order.

Priming water for one new underground pumping station is taken from the dust-allaying spray water system. An automatic cut-off is provided to disconnect the spray system as soon as the pump takes up its load.

Drainage Systems

Use gravity flow and pumps alternately to minimize power consumption for drainage.

Improved drilling techniques increase the advantages of pumping through boreholes.

FITTING THE PUMPING SYSTEM into the overall mining plan is another matter. This is another instance where each setup is somewhat different from any other, as local conditions dictate. An example of how to get the most out of a dollar of drainage cost is shown in an accompanying illustration, where three gravity-fed sumps and three pumping stations remove 3,000 gpm in three stages over a distance of 3½ mi. Each station is provided with independent pumping power through a borehole cable. Wood pipe in 8-, 10-, 12- and 16-in diameters is used.

The two main pumps at this property operate on alternate 12-hr cycles thus making a peakless pumping load on the power system. The sumps act as accumulators in making this duty possible. If level power demand is important, either to head off penalties in the power bill or to prevent overloads on conversion substations, this method could be used.

At an anthracite mine the problem was to unwater some workings on the other side of a 200-ft barrier pillar to permit recovery of the pillars in the flooded mine. Broken strata above the workings ruled out the possibility of using a borehole to the surface. The solution, as shown in an illustration, was to drill a pair of 12-in horizontal holes from the active mine through the barrier pillar to tap the flooded workings. The borehole lines were connected to a 7,000-gpm 700-hp pump which discharged through 2,300 ft of 18-in asbestos-cement pipe installed in the slope of the active mine.

It was found in this job that it was possible to locate the pump at an elevation where a positive head on the suction lines could be used to balance a portion of the discharge head against which the pump had to work, thus saving power. And it was found also that the most difficult part of the job was restraining the 18-in discharge line with the pump operating at full head. The solution to this required the installation of steel bands bolted to floor and rib around the pipe on each side of each joint.

The pump and its drive motor were mounted on mine-car wheels to make it easier to replace either unit.

At another anthracite property, it proved to be more advantageous to drill two 24-in boreholes from the surface to a depth of 537 ft to reach the best natural sump in a worked-out lower vein. Upper veins then could be drained into this sump through smaller boreholes which were drilled at intervals as the workings advanced to keep the pipelines to gathering pumps as short as possible. The two larger boreholes each serve a 4,400-gpm 10-stage pump, driven by a 700-hp 4,000-v AC motor.

Incidentally, both of these anthracite drilling operations were let out on contract to a company that specializes in these projects. When jobs of such magnitude must be done, it pays to get the best services.

The possibility of using boreholes and vertical-turbine pumps in combination should not be overlooked. New drills, for sinking the boreholes faster and cheaper, make this system worth notice.

Cutting Drainage Costs

Automatic controls at pumping stations reduce the need for attendance, when properly inspected and maintained.

Lightweight materials and fast couplings result in lower labor costs for pipeline installation.

SO FAR, the drainage plan has been built up to take full advantage of the economies in surface-water diversion, gravity handling wherever possible and proper pump selection and application. There is one more requirement to be satisfied. That is, the system must now be operated and maintained with minimum expenditure of service labor. This means that pumps and other drainage equipment must give longer trouble-free service, pipelines must last longer, relocations of pumps and piping must be made in less time, and long runs of piping must be installed in the shortest possible time. Drainage costs can be kept under control only to the extent that these goals are met.

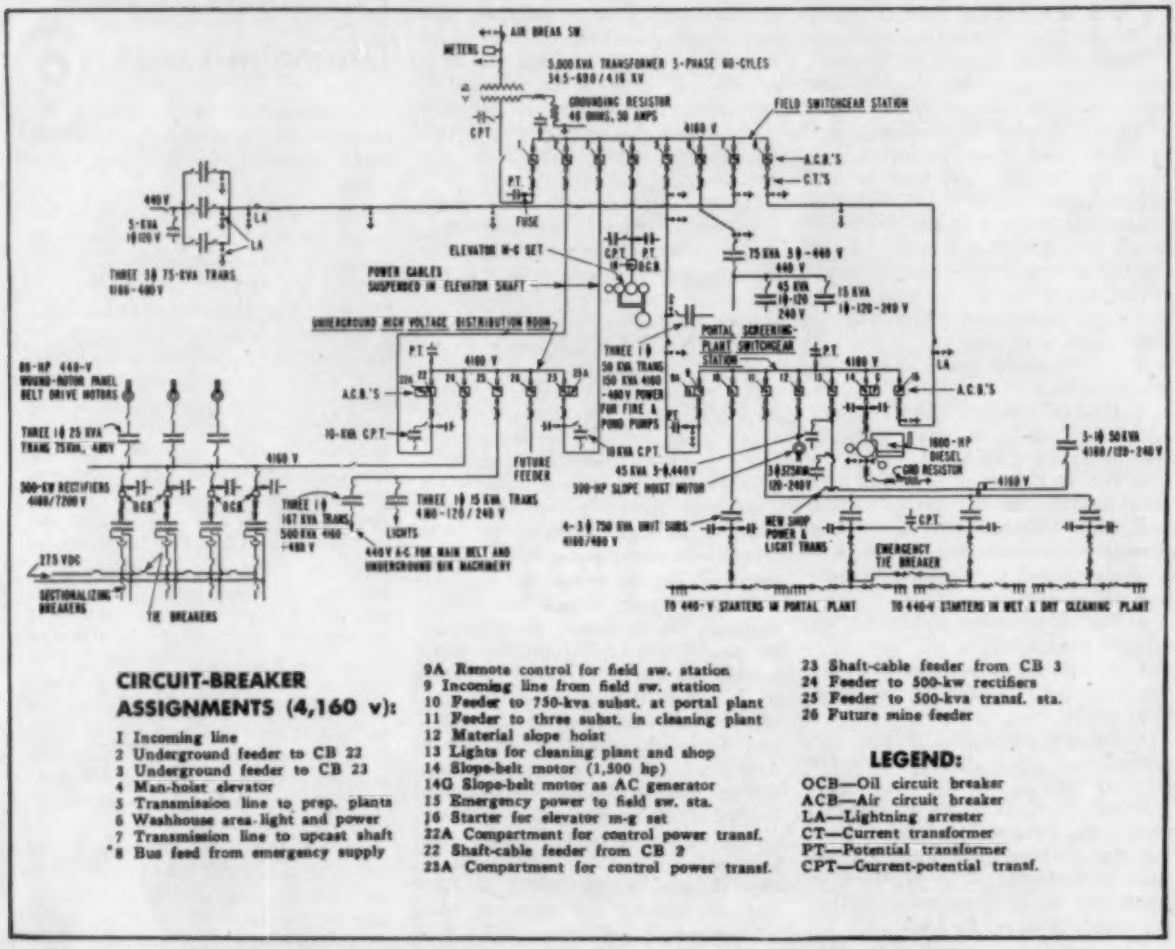
Every manufacturer of drainage supplies designs his equipment to perform one or more of these functions. Here are some examples.

Saving Labor in Pumping—Pump controls ranging from simple float switches to elaborate fully-automatic systems for large stations are available. Modern pumps can be made of special alloys or lined with coatings which increase pump life in handling corrosive waters.

Longer Pipe Life—Asbestos-cement, plastics, aluminum alloys, synthetic rubber, special coatings—all these materials in the form of mine pipe have materially increased in the time-in-service for underground pipelines. The happy result is that since fewer pipe changes are necessary, the drainage system can be maintained with fewer men.

Faster Relocation — Fast snap action couplings for use with plain-end pipe now permit fast disassembly and reassembly in a new location of pipelines up to 6 in in diameter. Grooving machines now are available for modifying plain-end pipe to take the faster self-aligning couplings.

Quick Installation of Longer Runs —Long coils of lightweight plastic pipe or long sections of aluminum pipe now can be installed by one or two men, where the same men formerly would be hard-pressed to lay a fraction of this length in the same time.



CIRCUIT-BREAKER ASSIGNMENTS (4,160 v):

I Incoming line
2 Underground feeder to CB 22
3 Underground feeder to CB 23
4 Man-hoist elevator
5 Transmission line to prep. plants
6 Washhouse area light and power
7 Transmission line to upcast shaft
8 Bus feed from emergency supply
9A Remote control for field sw. station
9 Incoming line from field sw. station
10 Feeder to 750-kva subst. at portal plant
11 Feeder to three subst. in cleaning plant
12 Material slope hoist
13 Lights for cleaning plant and shop
14 Slope-belt motor (1,500 hp)
14G Slope-belt motor as AC generator
15 Emergency power to field sw. sta.
16 Starter for elevator m-g set
22A Compartment for control power transf.
22 Shaft-cable feeder from CB 2
23A Compartment for control power transf.
23 Shaft-cable feeder from CB 3
24 Feeder to 500-kw rectifiers
25 Feeder to 500-kva transf. sta.
26 Future mine feeder

LEGEND:

OCB—Oil circuit breaker
ACB—Air circuit breaker
LA—Lightning arrester
CT—Current transformer
PT—Potential transformer
CPT—Current-potential transf.

MODERN AC SYSTEM provides adequate steady power for continuous mining, maximum safety for the men in the mine, and full protection for mechanical and electrical equipment.

Electric Power

Primary Power ..... p 94
Mine Power Selection . p 97
DC Service ..... p 98
AC Service ..... p 101

ELECTRICAL SUPPLY SYSTEMS should be planned to give maximum service, to include adequate protection for equipment and personnel, and to supply rated voltage to motor terminals at normal running loads. The system should be designed to deliver higher than rated voltage when load demands are heavy. However, voltage should not exceed the limits imposed by motor design—usually not over 10% over or under rating. A slightly higher than rated voltage might mean the difference between a lot of equipment trouble and no more than normal.

Essential items necessary to maintain good electrical service are good power factor of the AC system, transformers of the proper rating, sufficient copper to transmit voltage reasonable distances and, where DC is used, the necessary converting equipment to produce the required kilowatt capacity.

Primary Power

Plan to distribute power in one or two steps, whichever proves more economical.

Have all incoming power metered at one point.

Improve system power-factor by proper motor sizing, and use of synchronous motors and capacitors.

WHETHER TO DISTRIBUTE in one or two steps is the first question that arises in setting up or revising primary electrical power facilities. Careful consideration should be given to mining methods and conditions, maximum distances voltage is to be transmitted, and whether the overall mine system will be AC or DC. Normally, the one-step system is the one employed, with either 2,300 or 4,160 V as the nominal transmission pressure. The trend is toward 4,160. And as reflecting increased concentration, loads and transmission distances, particularly for cables, 7,200 V has already entered the picture, with possibly 13,000 at some future date.

Two-step systems are relatively few in coal mining, and where they have been adopted the "super-primary" voltage usually is 13,000.

Three-phase transformers are growing in popularity, though the old-reliable single-phase units are still in the majority. But whether three-phase or three single-phase stations are employed, protection should include lightning arresters, circuit breakers, ground-protective equipment and other control and protective facilities. The two accompanying diagrams show the facilities at two new mines, including control and protective equipment, as well as how the circuits are set up to serve surface facilities in addition to underground. One plan, it will be noted, includes a 1,600-hp diesel emergency generator.

Central Metering—Where power is purchased for two or more mines, it usually is worth a fair investment in extra lines and equipment to permit metering at one point.

Power Factor—Without correction power factor at the average coal mine would be 60 to 85%—sometimes less but seldom more.

Reactive KVA loads up the system, including power lines, generators and transformers. This causes just as much heating as an equal amount of power-making KVA. If the system is overloaded, improving the power-factor will reduce the load and the equipment will last longer, will be safer and maintenance will cost less. Too, there will be less voltage drop, motors will start heavy loads more easily and downtime due to undervoltage will be less.

Power-factor improvement can be accomplished economically by the following procedure:

1. Select the correct sizes of induction motors so they will be fully loaded as much of the time as possible.

PROTECTIVE EQUIPMENT IN AC SYSTEM for new mine is shown by numbers: (1) primary fused cutouts; (2) secondary breaker; (3) 100-amp fused cutout with 80-amp links; (4) 50-amp fused cutout, 30-amp links, fan circuit; (5) 50-amp fused cutout, 50-amp links, shop transformers; (6) pole-top switch, 3-pole gang-operated, 7.5-kv, 400-amp, tipple circuits; (7) 200 amp 7.5-kv trip-out fused cutout, 125-amp links, tipple transformer bank; (8) 600-amp OCB, tipple circuits; (9) 400-amp OCB, tipple circuit; 50-amp fused cutout, 2-amp links, yard lights; (10) disconnect switch, 7.5-kv, 400-amp, hoist-house circuit; (11) 50-amp fused cutouts, 2-amp links, yard lights; (12-13) 200-amp fused cutouts, 5,000-v 200-amp links, 300-kw m-g set; (14) 200 amp fused cutouts, 5,000-v 150-amp fuse links, 150-kw m-g set; (15-18) 50-amp fused cutouts, 50-amp links, compressors; (19) 200-amp fused cutouts.

Trend Markers—Electric Power

AC expected to grow rapidly in the next few years because (1) AC motors, controls and substations cost less, (2) AC equipment maintenance is simpler and (3) AC is more versatile.

The availability of torque-converter and straight AC shuttle-cars, which eliminates DC at the face, is expected to be a deciding factor as to the type of power that will be employed in new installations.

Transmission voltages are being increased. The trend is toward 4,160 V, although a few mines are using 7,200.

Future Possibilities

As concentration, loads and transmission distances increase, 13,000 V may be expected to enter the picture at some future date.

If diesel-powered locomotives are permitted in the mines in the future it will be possible to eliminate DC entirely. This would tend to step up the conversion rate.

Case-Finder—Electric Power

AC Distribution—Higher voltages provide safety for men and equipment; circuits extended by sectionalized cable lengths. *Coal Age*, August, 1954, p 88.

Continuous mining with AC power and how it is distributed underground. *Coal Age*, February, 1956, p 88.

Cutting Power Bills—What the controlling factors are; how to apply them. *Coal Age*, October, 1955, p 76.

Dual-Purpose Borehole—Four 2-in pipes carry power underground in borehole also equipped with 4-in pump line. *Coal Age*, June, 1957, p 70.

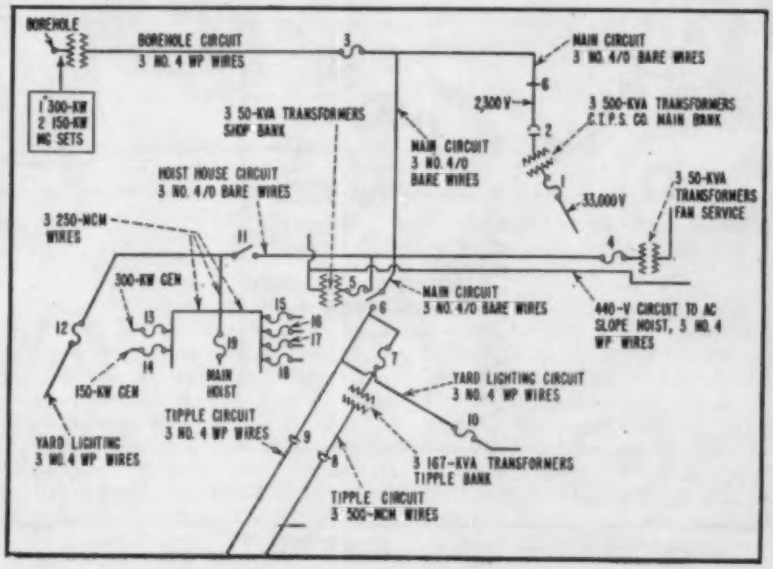
Installation of armored power cable in shaft. *Coal Age*, May, 1954, p 116.

Frame-grounding problems, solutions and how to devise better systems. *Coal Age*, February, 1955, p 84.

Automatic control of substations and fans utilizes carrier-current equipment. *Coal Age*, October, 1955, p 68.

DC feeder circuit breaker settings for overcurrent protection. *Coal Age*, November, 1953, p 86.

Method used to calculate load division of DC mine feeder circuits. *Coal Age*, August, 1955, p 78.



2. Use high-speed induction motors wherever possible.

3. Employ synchronous motors, 0.8 leading on M-G sets.

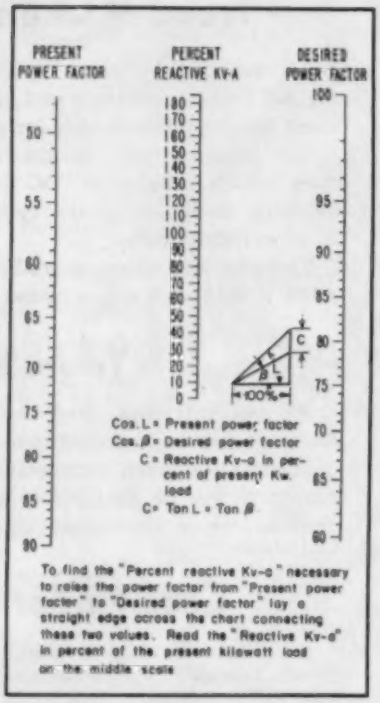
4. Use synchronous motors for equipment such as pumps, fans and the like, requiring, say motors of 100 hp or more.

5. Install capacitors to supplement other forms of correction.

Capacitors can correct and bring power factor up to 90 to 95%, which normally takes the mine out of the penalty area. Even if power-factor penalties are not included in the rate structure, improvement is warranted to reduce the wattless current in wire, cable and motors. Theoretically, correction should be installed with each induction motor of any size, but a more-practicable system is capacity for a group of motors near the center of such a group. The farthest-back location, and the least preferable as a rule, is the substation.

Distribution

Choices in distribution of 2,300 or 4,160 V AC include overhead pole lines to surface substations and facilities, normally bare wire but occasionally weatherproof cable; underground cable systems; and a combination of pole lines and cables. Where openings may be made along outcrops or the cover is not too deep for boreholes, the pole line normally

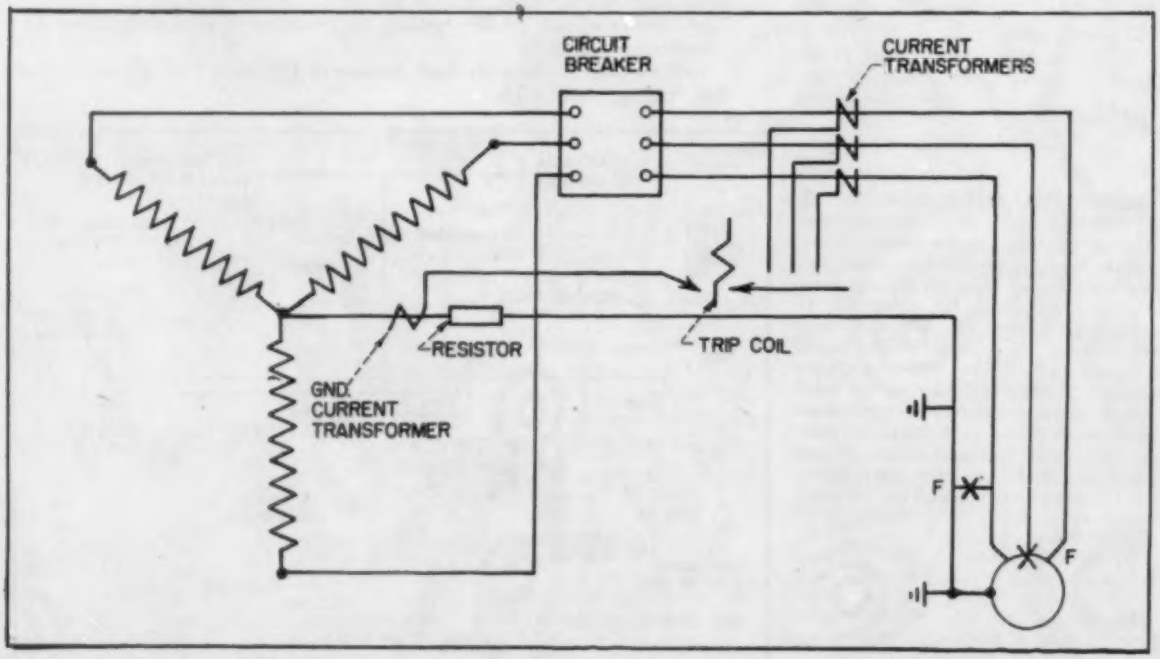

PRESENT POWER FACTOR
PERCENT REACTIVE KV-A
DESIRED POWER FACTOR
Cos. L = Present power factor
Cos. β = Desired power factor
C = Reactive Kv-a in percent of present Kw. load
C = Tan L - Tan β
To find the "Percent reactive Kv-a" necessary to raise the power factor from "Present power factor" to "Desired power factor" lay a straight edge across the chart connecting these two values. Read the "Reactive Kv-a" in percent of the present kilowatt load on the middle scale

BEST METHOD OF CORRECTING POWER FACTOR in a given case can only be determined by a careful study of surrounding conditions. Without taking into consideration special features, the amount of corrective KVA may be determined by the use of the above nomagraph copyrighted by Westinghouse Electric Corp.

is preferred. Man-and-materials or air shafts back from the main portal are other spots where pole lines may be terminated. If the rule of not over 3,000 to 3,250 ft for transmission of 250-V DC or 440-V AC is observed, and unless a system can be worked out so that the opening can serve 3,000 to 3,250 ft outby as well as inby, new openings and terminals for the pole lines theoretically would have to be established every 0.6 mi. An alternative is a certain amount of underground cable to supplement the pole lines.

Putting the primary distribution system on the surface, other things being equal, provides a better opportunity for developing a system providing for feeding most key points from two directions. Even if extra line is necessary, the insurance against interruptions may more than overbalance the cost. Laying out an underground cable system to feed from two directions may be more difficult or impracticable, but a check on feasibility should be made in any event.

Type SHD cable, rated at up to 15,000 V, is becoming the most popular type for underground service. Each insulated conductor is covered with copper shielding braid to equalize surface stresses and eliminate static discharge—the cause of corona cutting. Grounding conductors, one for each power conductor, are placed in the interstices. A neoprene jacket over all completes the assembly.



AC CIRCUIT PROTECTION by grounding transformer circuit to neutral of Y-connected transformer secondary.

Borehole and Shaft Installation—Neoprene-jacketed cable may be used in taking AC down boreholes or shafts, provided, among other things, depth is not too great. Deep shafts or boreholes usually warrant armored cable, which can be supported by the armor wires with no strain on the conductors and, in shafts, is protected against falling material or moving equipment.

With neoprene-jacketed types, the entire cable, if it is short, may be hung from a clamp or basket-weave grip at the top. Longer cables may be clamped to a messenger wire in boreholes. A more frequently used type of suspension is supporting the entire weight of the cable by clamping each conductor to a separate strain insulator.

Preferred procedure in installing cables in boreholes is to pull the cable up through the hole with a wire rope and hoist, truck or bulldozer. Where it is necessary to lower the cable, the reel must be provided with adequate braking facilities. A bulldozer or some other heavy piece of equipment may be employed to control lowering of the entire cable or the final end into the hole. For example of bulldozer use, see *Coal Age,* May, 1954, p 116.

Looping may be used to lower cables into shafts. One end is permanently anchored and the other is lowered by a wire rope. The cable loop in the shaft should be at least as large as the diameter of the cable reel. Items required in this lowering method include a large sheave at the shaft, a pulley system along the ground for controlling lowering, a truck to pull the cable into the shaft, and a bulldozer for retarding when enough cable is in the shaft to pull the remaining section in.

A new idea in borehole installations provides power distribution and drainage through one borehole. Four 2-in pipes to carry power conductors and one 4-in pipe to remove water are grouted into a 10-in borehole. The borehole should be located near active producing sections, thus eliminating long-distance power transmission and pumping. Details of this installation can be found in *Coal Age,* June, 1957, p 70.

Underground Installation—Where adequate protection and grounding are available, neoprene-jacketed cable may be installed in accordance with the same standards as armored cable. In other words, it may be supported on messenger wires or directly on hangars, both suspended by insulators, or it may be buried. The location may be either the intake airway or the haulage opening, provided, particularly in the latter instance, that proper protection against moving equipment and other hazards is provided.

A new trend in aerial installation is the supported cable along the rib or roof. In one version, the conventional power cable is tied to a high-tensile messenger cable by metal binding straps. Or, three single-conductor cables may be tied to the messenger. Easier connecting and tapping are single-conductor advantages.

Protection

Major items involved in the protection of AC distribution systems, particularly of the cable type, include the following:

Approved-type lightning arresters at the point where the circuit enters the mine, as well as back at the substation if the entrace is some distance from the sub-station.

Outside switching facilities comprising either a disconnecting switch or a circuit breaker, preferably the latter. The breaker should trip on both phase overcurrent and ground-fault current.

Disconnecting equipment at the bottoms of boreholes, if entrance is by this means, preferably subway-type oil cutouts or oil switches.

Suitable disconnect switches at each branch circuit. These may be the same as equipment used at borehole entrances. In more-comprehensive systems, where automatic sectionalization may be desirable, circuit breakers with suitable relaying equipment may offer advantages.

Suitable junction boxes and couplers. Plug-in-type couplers should be interlocked so that the key for opening one can be obtained only by opening a switching device ahead.

Grounding—The primary duties of ground wires in high-voltage cable and in surface lines associated with such cable are (1) to operate ground-protective equipment, and (2) to keep equipment connected to the high-voltage circuit at as near ground potential as possible. Ground wires should be metallically connected to equipment frames. They should be continuous, they should be checked from time to time to see that they are continuous, they should be protected against stray DC currents, and they should be checked regularly to see that they are not carrying excessive stray current—on the order of 40 to 50 amp, which normally means a defective DC return. The final touch in good grounding is connecting each item of equipment served by the cable circuit to a driven ground rod near each unit.

The mine grounding system should be kept separate from the grounds serving the equipment and lightning arresters at the transformer station. This protects men in the mine from the possibility of shock from lightning outside.

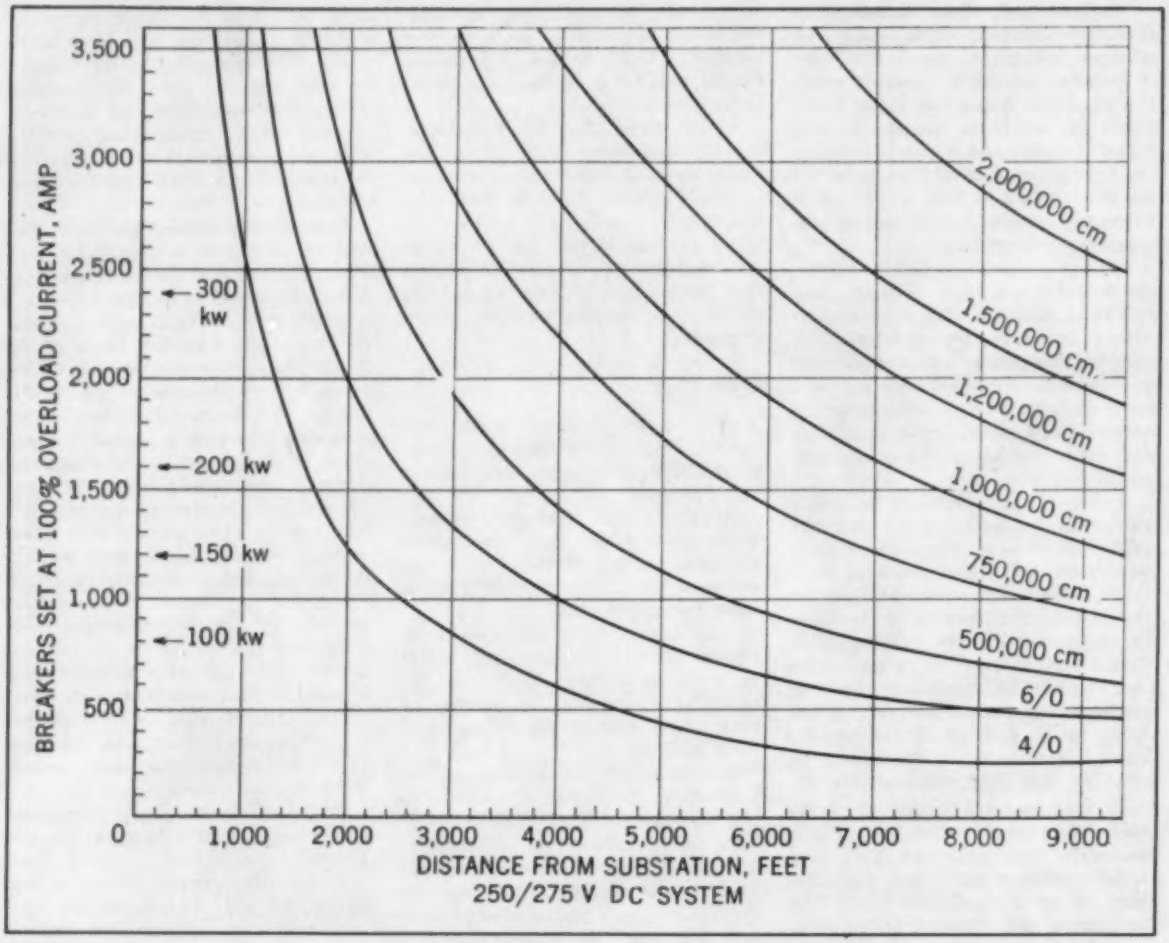
Ground Protection—To limit the flow of current in a ground to, say, 25 to 50 amp, and thus also limit the voltage to which a man is subjected in coming in contact with a piece of equipment affected by a short or ground, customary practice is to connect the protective ground to the neutral of a Y-connected transformer secondary through a grounding resistor and current transformer, as shown in the accompanying diagram. The current transformer operates the trip coil to open the breaker. The same effect can be secured with a delta-connected secondary by using a zig-zag transformer to establish a neutral. To permit establishment of a grounded neutral it is recommended that the mine be served by a separate transformer station, even if the ratio is only 1:1. However, by proper switching and relaying, the mine station can serve certain other 3-phase loads.

The accompanying diagram also shows current transformers for detecting ground-fault current and opening the breaker within a few cycles not only to reduce the time men might be exposed to hazards but also reduce equipment and cable damage. Other methods of detecting ground-fault current include the "window" or "doughnut" transformer around the three power wires—but not the ground wires—and the three-phase current transformer with single secondary.

Mine Power Selection

Consider the use of AC power at the face as a result of the availability of torque-converter and straight AC shuttle cars.

AC SHUTTLE-CARS recently placed on the market have eliminated the need for DC at the face. However, with locomotive haulage, DC is still a necessity for at least part of the mine load. If, in the future, diesel locomotives are permitted in the mine it will be possible to eliminate DC entirely. The advantages of AC are numerous and substantial, and therefore, even if DC is retained for haulage, warrant



LIMIT OF CURRENT FLOW in a circuit at various distances from substations for various sizes of conductors is shown in the above chart.

careful consideration for other mine operations.

AC advantages include the following:

Motor cost averages two-fifths the cost of DC motors.

Cost of 220-v AC control is about the same as DC; 440-v is less.

Portable AC substations are less than one-third the cost of DC conversion equipment.

AC equipment maintenance is simpler.

AC is more versatile. Therefore, it is easier to handle a variety of loads. For a small isolated unit, as an example, AC equipment includes a small combination substation and motor starter.

With AC, on the other hand, reactance and power factor must be taken into account along with the usual resistance and load current. Voltage drop during the starting period must be kept to not over 15% to insure contactor operation. With DC, the maximum drop is 20%. The speed of AC motors is not materially affected by changes in voltage—within reasonable limits—but the torque output is affected more than with DC motors because with AC it varies as the square of the applied voltage.

Voltage—As machine horsepower increases, the burden on trailing cables with 220- or 275-V power increases. In many areas, these are the maximum voltages permitted at the face. There are indications, however, that relief is in sight, though it still may come rather slowly. As an example, the new Indiana mine law permits up to 680 V at the face.

Where it is permitted, going to voltages higher than 220 or 275 should receive the most earnest consideration. With the same-size conductor and the same distance, twice the load can be handled with 440-V power compared to 220, for example. Conversely, with the same conductor size and load, power can be transmitted twice as far with the same voltage drop and losses.

DC Service

Plan conversion equipment installation to meet the increasing power demands of equipment.

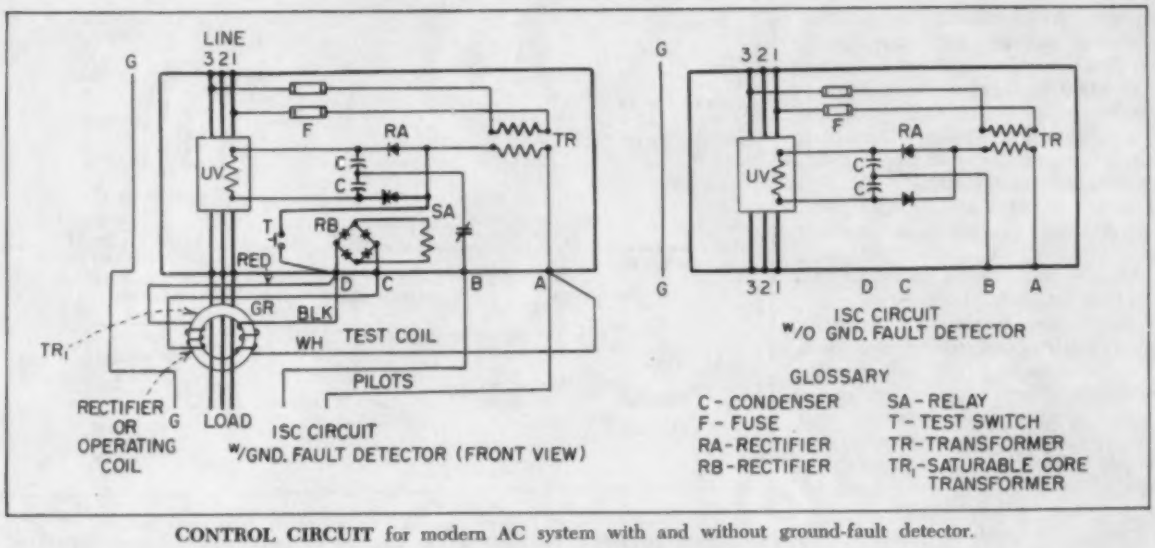
Weigh the possibilities of converting manual substations to automatic controls.

Provide sufficient feeder capacity and stay within maximum transmission limits.

Have DC system sectionalized.

CONVERSION EQUIPMENT includes the old-reliable converters and m-g sets, but the standard unit today is the mercury-arc rectifier, including the glass-bulb type. A few metallic rectifiers of the selenium type are in service and units based on germanium, silicon and other metals are under consideration.

Conversion Capacity—Higher horsepower per machine and per section is requiring an increase in the capacity



CONTROL CIRCUIT for modern AC system with and without ground-fault detector.

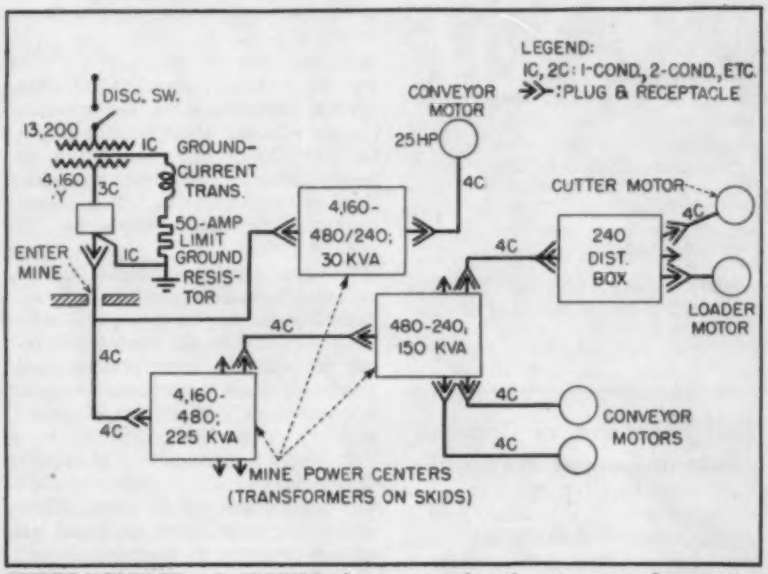
of rectifiers and other conversion equipment. A recent series of tests on power required by continuous miners indicates that the capacity for a single section (miner and shuttle cars, roof drill, etc.) should be at least 200 kw.

Dull bits on miners and other equipment have a major effect on power demand and consumption. In one test with dull bits, miner advance was 20 ft, demand was 82.4 kw and consumption was 32.47 kwhr. Time was 50 min. With sharp bits, advance in 54 min was 30 ft. Demand was 69 kw and consumption was 31.33 kwhr (J. O. Cree, 1956 Coal Convention, American Mining Congress).

Automatic Operation—The high cost of labor naturally dictates making substations automatic unless attendants can grind bits, splice cables or perform other duties. Equipment now is available for checking position and operating breakers at will from a central station several miles away (*Coal Age*, October, 1955, p 68). The system is based on carrier current using telephone lines for transmitting audio signals.

Portability—For the maximum in convenience and efficiency, the trend is toward portable conversion units. Such units also may be placed in permanent locations—to serve main-line haulage, for example. Or stationary types may be employed at some saving in cost.

Portability facilitates keeping transmission distances short. However, if the cover is shallow, some mines have felt that the lower cost of pole lines and surface facilities; even when offset by the cost of boreholes, warranted keeping conversion equipment



THREE-VOLTAGE AC SYSTEM, showing outside substation, ground protection and mining equipment served.

on the surface, even with 275 V as the nominal voltage. With 550 V, the reduction in number of moves otherwise necessary is an added reason for considering keeping conversion equipment outside.

Heavy locomotives bring up the problem not only of placement and capacity of substations but also the effect on the remainder of the system as the locomotive passes a given point. To reduce disturbance in face operation as a result of locomotive operation, substations may be equipped with automatic load distributors.

The Inverted Trolley—For locomotive operation, a newcomer in service is the inverted trolley (*Coal Age*, October, 1952, p 87). As the name implies, the trolley is placed on top of inverted hangers, and the locomotives receive power through sliding shoes pulled by cables.

Transmission Limits

The maximum distance DC can be transmitted from the substation depends on a number of factors, and must be calculated for each individual operation. Balancing everything, the distance should not exceed 3,000 to 3,250 ft for an 800-amp average transmission, 300 V at the nips and 250 V at the machine.

Even with the maximum in feeder

capacity it is difficult to maintain adequate voltage, let alone rated, for 250-V motors at distances much over 4,000 ft. Incidentally in increasing feeder capacity, it is better to use a number of smaller cables than one large one because the current-carrying capacity is greater. At 30C ambient temperature, 45-deg rise, for example, approximate ratings are: 500,000 cir. mils, 800 amp; 1,000,000 cir. mils, 1,230 amp; 1,500,000 cir. mils, 1,550 amp.

Aluminum Feeder—A decidedly lower relative cost makes aluminum very advantageous for bare feeders alongside trolley wires or elsewhere. It has greater bulk, however, and consequently the advantages are largely offset by the increased insulation and jacket when used for high-voltage power cables or low-voltage trailing cables. But with bare feeder, aluminum has about 70% the current-carrying capacity of copper, and 3 ft of aluminum feeder can be bought for the price of 1 ft of copper.

Edison System—One possible answer to the problem of keeping substation moves down while keeping voltage up is the three-wire, or Edison, system (*Coal Age*, July, 1947, p 86).

Sectionalization

Safety, quick isolation of fault areas, and quick replacement of damaged facilities are among the benefits of sectionalization. The latter applies particularly to the growing custom of using short lengths of cable with push-pull connectors in distribution of power at the face. Connector design is such that power is removed before the circuit is opened.

Recommended sectionalizing practice may be summarized as follows:

1. Provide in every instance sufficient capacity in the feeder and return so that the most remote dead short will open the overcurrent protective device, usually an automatic reclosing circuit breaker.

2. Install an overcurrent protective device in the circuit between each two substations at a point where resistance both ways is equal. If enough copper is used so that a ground at any point will open the protective devices at both substations, no intermediate protection is necessary. A section insulator, or "dead block," may be used between substations if they need not be paralleled.

3. Insert a disconnecting switch or protective device at intervals of not over 1,500 ft in all power lines.

4. Install an overcurrent-protective device in each circuit leaving a substation—fuses, or manual or automatic-reclosing circuit breakers. Circuit breakers should have trip-free operting mechanisms. The exception is where a substation feeds only one haulage unit, in which case only one station breaker is required.

5. Place an overcurrent protective device at each branch circuit.

6. Protect each circuit feeding a local section or territory with an overcurrent device.

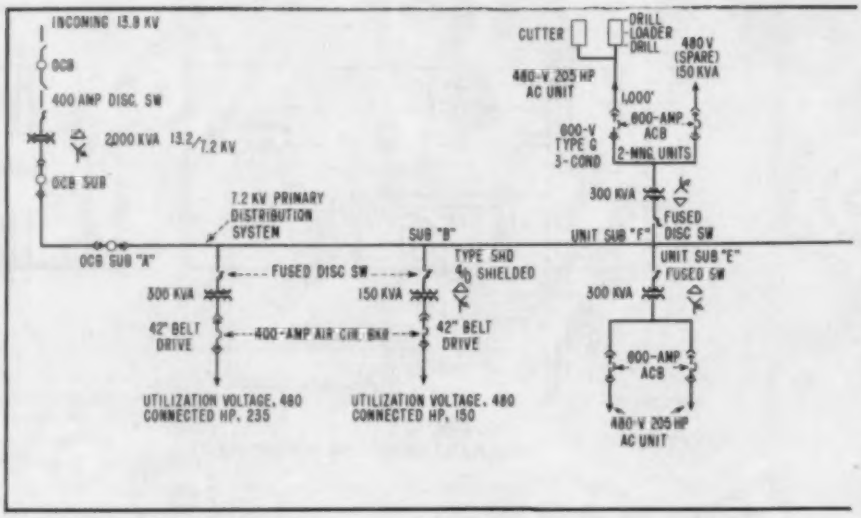
7. Install overcurrent protection at the supply end of each circuit to pumps or other fixed loads.

8. Install switches to cut power off unimportant and infrequently used branch or stub circuits.

9. Protect each mining setup with an overcurrent device.

10. Keep overcurrent circuit-breaker settings or fuse ratings as low as practical for good operation. Specific settings are listed in a discussion of the subject in *Coal Age*, November, 1953, p 86. How to calculate load division as a guide to choosing breaker settings is detailed in *Coal Age*, August, 1955, p 55.

11. Cut power off all idle territories during non-operating times. If it is necessary to run a pump or some other one unit, special overload protection no greater than needed should be provided.



MODERN AC MINE SETUP designed for 7,200 V distribution by Type SHD 4/0 shielded cable. Oil circuit breakers are equally spaced in the high-voltage line. Fused disconnect switches are placed on the high-voltage side of each power center.

Unit Resistance of Common Sizes of Copper Wire and Steel Rail

COPPER WIRE

Size, CM	*Resistance Ohms per 1,000 Ft*
1,500,000	0.00719
1,200,000	0.00899
1,000,000	0.0108
750,000	0.0144
500,000	0.0216
300,000	0.0360
211,000	0.0509

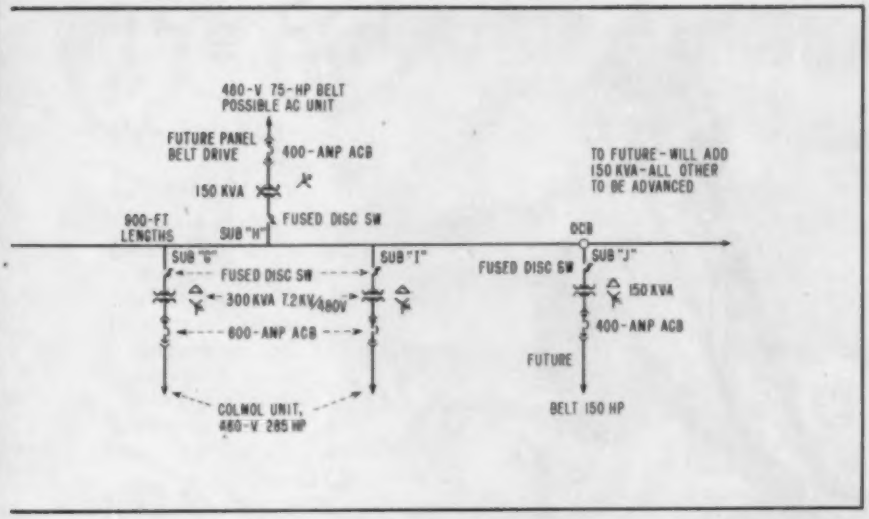
STEEL RAIL

Weight	*Equivalent Each Rail, CM of Copper*	*Resistance, Ohms per 1,000 Ft (Both Rails Bonded and Cross-Bonded)*
30	300,000	0.0180
40	400,000	0.0135
50	500,000	0.0108
60	600,000	0.0090
70	700,000	0.0077
80	800,000	0.0067
90	900,000	0.0060
100	1,000,000	0.0054

Ground Protection

The solid wire from machine frame to ground provides protection to men from short circuits—under most conditions—but no protection to the machine. Thus, some other provision is necessary. The original unit, still widely used, was the fuse, either in the junction or distribution box or in the trailing-cable nip. A major disadvantage is that a ground fault of low intensity, say 100 amp, is not sufficient to blow a fuse—or operate a circuit breaker—rated or set at 200 amp.

The best answer to this latter condition is a three-pole circuit breaker,



Transformers are connected "delta-wye" for grounding purposes. Air circuit breakers of the proper rating are provided at the load center. The system provides protection for men and equipment.

with one pole in the grounding circuit equipped with a 5- or 10- amp current-limiting relay. A low-intensity fault will trip the breaker as a signal for corrective measures, while a high-intensity fault will be cut off before severe equipment damage occurs.

Proposed alternatives, particularly for such mobile units as shuttle cars, include the polarized relay, the polarized short-circuiting device and certain electronic devices (*Coal Age*, February, 1953, p 84).

AC Service

Take into account maximum transmission distances and power demands before selecting the primary and secondary voltages.

Provide protection for equipment and personnel.

Select cables and transformers of the proper rating to receive full benefit of AC service.

PRIMARY VOLTAGE is the first factor to consider when setting up an AC mine system. Usually, it is more economical to use a higher voltage in the range of 4,160 V and going as high as 7,200. Maximum transmission distance and demand are the two governing factors.

Underground distribution systems consist mainly of high- and low-voltage cables, power centers, load centers and necessary protective devices.

Even though 7,200 V is the maximum underground voltage in service today the Type SHD cable, rated at up to 15,000 V, is the most popular type for underground use. The size of cable used to transmit voltage to the mine power center usually is 4/0.

Capacity of mine power centers generally ranges from 100 to 300 kva, depending on load demand. Most transformer sections of this type have a primary oil circuit breaker or the equivalent. When connecting transformers "delta-wye", current-limiting resistors in the neutral and ground trip circuit breakers are employed to provide a neutral for the low-voltage side. The "delta-delta" system uses a grounding transformer to establish a neutral.

The inherent hazards of oil-filled transformers make nonflammable coolants a must where liquid types are employed. But even when the coolant will not burn, it still has weight and thus makes moving transformers more of a job, especially in thin coal.

Load centers can be a combination power-load-center or separate units. The latter offers more flexibility in that fewer moves of the power centers are required. When the single units are used cables of fixed lengths are inserted in the line to extend the distance between the power and load centers. Whether the combined or single units are employed, a circuit breaker should be placed in the low-voltage line to permit cutting power off all equipment. Each unit of equipment should have an individual circuit breaker of the proper rating to protect cable, equipment and personnel on the job.

Operating voltages of 440 or higher at the face (up to 680 V in Indiana) considerably ease the problem of face distribution with AC. Where the limit is 220 (nominal), trailing-cable limitations make it impractical to transmit AC more than a few hundred feet. This requires the use of an intermediate voltage or frequent moves. The latter are facilitated in low coal by skid mounts and dry-type or sealed transformers to reduce weight. Another method of maintaining adequate voltage to face equipment is to install booster transformers near the equipment. Voltages can be increased as much as 10%, which in most cases overcomes the line loss.

Where an intermediate voltage is employed, it normally would be 440 (nominal), though it could be higher. With 500,000-cir. mil conductors, and taking into consideration moving and other costs, the practicable distance with 440 V is about 3,000 ft. How one three-voltage system is set up (*Coal Age*, September, 1952, p 91) is shown in the accompanying diagram. Among other things, the diagram illustrates the use of the grounded neutral system for protecting men and equipment summarized in the discussion of "Primary Power" earlier in this section.

Another modern AC power-distribution setup underground is shown in the accompanying schematic drawing. It involves a primary voltage of 7,200 and an operating voltage of 480. Oil and air circuit breakers and fused disconnect switches are employed to protect men and equipment and to sectionalize each section. Maximum transmission distances and demands were considered in the design. As noted in the drawing, future development also has been included.

Circuit safety can be provided in AC systems by adopting the "intrinsically safe" principle. This makes use of pilot wires in the cables to open the breakers and permit cables to be connected or disconnnected between lengths or to power centers, circuit centers and junction boxes with no danger of incendiary arc. Undervoltage protection can be provided at the same time. Ground-detection may also be provided by means of a detector coil around the power leads, a bridge rectifier and a sensitive relay (*Coal Age*, August, 1944, p 88). A pushbutton is provided for testing the circuit.

ABILITY to dig deeper and spoil farther is incorporated in modern shovel design.

Where to Find It in . . .

The Strip-Mining Guidebook

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Bulldozers . . . Tractor-Scrapers . . . Shovels . . . Draglines . . . Machine Operation . . . Pit Cleaning . . . Stripping Thick Cover . . . Two-Seam Stripping . . . Augering

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Drilling and Shooting . . . Cleaning . . . Loading

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The Strip-Mining Guidebook

Preparing for Operation

Prepare or obtain detailed maps so that an estimate can be made of recoverable coal, outcrops plotted, boreholes spotted, haul roads laid out and stripping ratios calculated.

Prospect the area and put the information on maps.

Select plant site as near a central location as possible so haulage distances will be as short as possible.

Lay out a permanent haul road between the plant and pit with good alignment and grade.

Select equipment with matched capacity for efficient operation and suited to natural conditions.

THE SUCCESS or failure of a new strip operation depends to a large extent on how well the ground work is laid. To lay the foundation for a successful operation, a careful study of many factors must be made before the mine is opened.

What are the ingredients that go into planning a successful operation? Planning should begin with acquiring enough property to provide a reasonable reserve or life. The first step in preparing or establishing the coal reserves is surveying the surface for topographic data and drilling to find out how deep the cover is, how thick the coal is and what the quality of the coal is.

After gathering the engineering data, it should be funneled to a central point where it can be recorded and analyzed. Problems or questions involving surface and mineral ownership, restrictions, coal thickness, type and quantity of overburden are bound to come up. To provide the answers and a ready reservoir of information, good records should be kept.

Planners must decide which market the mine is to serve and also to what extent preparation is to be carried out. Today's customers are aware that properly sized and well prepared coal can mean much in dollar savings through economical operation of a modern industrial plant. He is, therefore, interested in what plans the company has for providing economical and efficient coal preparation. In developing a new mine the company must acquire or set aside enough land to provide room for a modern preparation plant.

Good planning does not stop with the designs for mining and preparing the coal, but includes restoring the land to usefulness. The type of restoration work depends on the topography and type of overburden. There is a definite need to prevent erosion and conserve the land for future productivity. In some cases, land can be restored to return a profit either in the form of grazing land for cattle or in other cases trees can be grown profitably.

Any development program at a new property must be well financed and well planned. This is necessary if the customer is to be served properly, the owners given a fair return on their investment and the land left in condition that will serve a useful purpose in the future as well as in the present.

Aerial Surveying

Good maps used wisely, can provide a solid foundation for planning development and day to day operation of a strip mine. Today, maps can be made to any desired scale at only a fraction of the cost 10 yr ago by use of aerial surveying. The long, tedious ground survey is rapidly being replaced where large areas must be mapped in a minimum of time. Alert management men are turning more and more to aerial surveys to make accurate maps of all types for studying prospective stripping sites.

Trend Markers—Strip Mining

Stripping shovels continue to grow in size as 60-yd machine proves itself by moving overburden at a rate well over 2,000,000 cu yd per month. Several 70-yd units, now under construction, are expected to be ready for operation in the near future.

Draglines used where flexibility and long range required.

Worker comfort and ease of operation stressed in design of air conditioned operator's cab on new 55-yd shovel.

More vertical rotary dry-type drills added to speed overburden preparation.

Rotary sidewall capable of drilling 60-ft hole quickly passes trial test.

New explosives and lasting agents continue to appear with greatest gains with commercial grade ammonium nitrate.

Oil retarders make big gains as automatic braking devices on new trucks.

Turbochargers increase in use to boost the horsepower of diesel engines.

Parallel operation of transformers for portable power distribution systems successfully passes test.

Capacity of highwall augers for thin seams boosted with introduction of twin-head unit.

Future Possibilities

Higher voltages can be expected with the advent of increased horsepower in single excavators.

More application of industrial engineering techniques to analyze operations and set production standards.

Development of special tools and devices to handle parts as stripping machines grow in size.

More emphasis on operator comfort particularly in the larger machines now under construction or on the drawing boards.

Blowing of explosives into horizontal drill holes.

Aerial mapping also is more flexible than ground surveys and the same set of aerial negatives can be used for three jobs. They can be used for stereoscopic study of the land under consideration. They can be grouped into a mosaic which makes a good reconnaissance map. Then, when the area of interest is defined, a contour map can be made from the aerial photographic base. The speed with which these maps can be made is a major advantage.

An average topographic map can be made up in one-half to one-fifth the time needed for ground surveys at a sizable savings in cost and with no sacrifice of accuracy. With an aerial topographic map, an engineer can estimate coal acreage, plot crop lines, spot boreholes, determine and locate spoil areas, lay out haulage roads, compute overburden ratios and plot property lines.

A minimum of surface or ground control is needed in aerial topographic mapping. In some cases existing control may be entirely satisfactory. In others, it may be necessary to establish vertical control points for each photo and several horizontal control points along each flight strip.

When it is not practicable or desirable to have an aerial survey made, a ground survey may be required. The extent of the survey will depend on the lay of the land and how much information is already available, such as, topographic maps and geologic bulletins. If deep mining was done in the area, mine maps will provide a valuable source of information and will reveal a great deal about the nature of the coal. First, they will show how much, if any, coal is left between mine workings and the outcrop. Seam characteristics, including dip, thickness, unusual conditions and so on probably will be shown.

ACCURATE MAPS provide a solid foundation for planning strip mine development and operation. Low-cost maps can be made from aerial surveys.

Prospect Drilling

The next step after mapping is to assemble as much information as possible about the coal seam and mining conditions. Drilling is the most satisfactory method of prospecting coal for full and accurate information. This can be done either by churn or diamond equipment. Diamond drilling provides a core section of the overlying rocks and the coal, and therefore yields very valuable information. A churn drill in the hands of a skillful operator also can provide accurate data but is no proof that it is accurate. A coal core, on the other hand, can be examined visually and half of it sent to the laboratory for complete analysis. The other half can be kept for reference.

Development of a bottom-discharge bit that prevents air circulation around the core has made possible the successful application of air core drills. Air coring is said to make possible 100% core recovery nearly every time, even when it is necessary to stop half way through a seam. In soft, friable coal at least a 4x5½-in core barrel is needed to prevent the core from breaking and falling out. A very important advantage of air coring is that thin, soft partings of clay or other material are not washed out as they would be when using water. Another advantage is that water lines and pumps are eliminated.

In any drilling program, sufficient holes should be drilled to get an accurate picture of the coal bed. The drilling results should be plotted on the property map along with other key data. Isothickness lines should then be added to the map.

These lines will show how thick the coal is in the various areas and

Case-Finders—Strip Mining

Wheel Excavator—Wheel takes 25 to 30 ft, removing 10,000 cu yd per shift, while 33-yd shovel take 30 to 35. Wheel can operate to 50-ft bank height. *Coal Age*, July, 1956, p 60.

Two-Bench Dragline Stripping—30-yd dragline takes overburden off top bench; 6-yd walker removes 2½ to 10 ft of parting after shooting; two loading shovels—5- and 6-yd—load the benches into 30-ton trailers. *Coal Age*, July, 1956, p 76.

Four-Seam Operation—Two-step drilling and blasting first step in recovering four beds sandwiched in 63 ft or less of rock. A 5½-yd shovel removes top rock to permit three-step loading. *Coal Age*, August, 1956, p 88.

Augering After Stripping—48-in auger averages 400 tons per shift in 9-ft coal. It is preceded by 19-yd shovel working to 75 to 80 ft. Two dry-type rotaries and vertical auger drill overburden. *Coal Age*, September, 1956, p 64.

Augering in Tight Quarters—Three 42-to 50-in augers turn out 700 tons in one shift, a 1½-yd shovel and bulldozer bench in advance. Auger design permits working on as little as 28 ft. *Coal Age*, September, 1956, p 72.

Two-Seam Stripping—42-yd shovel will remove 40 ft of material over 4½-ft top seam after rotary drilling and ammonium-nitrate shooting. It is assisted through high spots by 13-yd dragline. Four-arm unit drills interval over 5-ft lower seam, which is removed by 6-yd highlift shovel. Loading into 51-ton haulers is done by 10-yd shovels. Unit substations are paralleled

PROSPECTING DRILL for locating seam outcrop or determining coal thickness can be mounted on lightweight truck that can travel over rough terrain.

will be useful in computing overburden ratios. This type of information on a map is especially helpful when the coal seam is irregular.

If the coal bed outcrops, prospecting should be done at regular intervals along the outcrop. The modern tool for this job is the bulldozer. Once the bulldozer is on the outcrop, it can make an opening faster and more economically than by hand methods. Outcrop openings can yield other useful information on the type and nature of the rock covering the coal and how much outcrop coal must be removed before merchantable coal is reached.

As prospecting information is accumulated, it should be put on a prospecting and property map developed from a topographic map base. Such a map will give a "bird's eye" view of the potential of the proposed stripping area. As the picture on the prospecting map takes shape, decisions can be made as to where more prospecting is needed and how much.

in a loop system—the first such setup. *Coal Age*, October, 1956, p 60.

Dry Rotary Drilling—New high-capacity tractor-mounted unit makes holes up to 9 in, is easily moved and provides penetration rates up to 12 fpm or more in shale. *Coal Age*, October, 1956, p 84.

Small-Diameter Augers—Production of 150 tpd is achieved from 24-in auger in 32-in seam. *Coal Age*, December, 1956, p 54.

Overburden Preparation—Today's drilling units, drilling patterns and breaking mediums. *Coal Age*, January, 1957, p 74.

High-Capacity Drilling—New crawler-mounted rotary sinks 50-ft hole without stopping. Drilling pattern adjusted to overburden depth and width of cut. Delay shooting employed. *Coal Age*, February, 1957, p 98.

Hilltop Stripping—Small diesel shovels and big bulldozers provide flexibility in overburden removal. Truck-mounted rotary unit handles drilling. *Coal Age*, March, 1957, p 82.

Stripping Without Shooting—Bulldozers supplement dragline and shovels for removing up to 60 to 80 ft to mine 42-in seam. *Coal Age*, April, 1957, p 66.

Tandem v Dragline Stripping—Practical limits for shovels and draglines working alone and in combination. *Coal Age*, May, 1957, p 81.

Updating Equipment—New shovel with higher lift, longer reach and greater horsepower cuts stripping cost 20%; service trucks save time and money. *Coal Age*, May, 1957, p 92.

Stripping 18-in Seam—Versatile overburden drill that cuts own road and high-lift shovel remove up to 50 ft of overburden. *Coal Age*, June, 1957, p 60.

The possibility of having a second valuable mineral present in the strip pit should be carefully checked. Some coal companies have added significantly to income by recovering at little or no extra cost fireclay under the coal and shale over it. Other companies have reaped a profit by recovering not only enough limestone for their own roadbuilding but also a surplus to sell to road contractors. These profit makers may be the difference between a marginal operation and a profitable one.

Plant Layout

If a new preparation plant must be built, the first job is to pick a site for it. Choice of a location is governed by access to rail facilities, suitable building space and nearness to the coal to be mined. Where possible, the plant should be centrally located so haulage distances will be as short as possible.

After the plant site is selected, the point to attack the coal seam should be selected. Then a permanent haulage link should be laid out to connect the preparation plant with the pit. A preliminary road layout can be made on a topographic map, along with estimates of the earthwork involved in building it. The field work then will consist of marking off the road route and making any minor adjustments.

In arriving at a permanent road layout, it should be remembered that good alignment and grades will pay off in faster haulage and lower truck maintenance. A solid, well-drained roadbed should be standard practice in all road design. Trucks should be able to travel at top speed whether loaded or empty, and drivers should be able to see clearly on all curves.

The mine layout will be governed by a combination of factors: type and contour of the overburden, coal thickness, coal quality and the quantity available. If the coal lies below drainage, a box cut will have to be made to gain access to it. If the coal is to be mined by following the contour or outcrop, a considerable sum of money may have to be spent to build roads to the coal level. If it is not desirable or feasible to haul coal downhill to the preparation pant, a bin feeder and conveyor setup will be needed at the dumping point to link it and the cleaning plant. The final selection of method will have to be made after a careful analysis.

Selecting Equipment

Closely linked to the mine layout is the selection of equipment for all

phases of the operation. Natural conditions along with economic factors will largely determine the type and size of equipment to be used. The key question will be how many cubic yards of waste material can be economically handled to recover a ton of coal. Today there is no simple or magic formula that can be applied to determine the economic stripping limit. A realistic set of estimated cost figures is the best guide. When the limit is determined, equipment capable of working to the limit can be considered.

Estimated cost figure should include a complete breakdown according to the accounting procedure that will be followed when the mine is operating. For example, labor and material costs should be carefully estimated for such things as drilling, shooting, stripping, explosives, pit cleaning, coal loading, road building, fuel, oil and grease, maintenance, supervision, depreciation and any other items necessary to arrive at fairly accurate estimated mining cost.

To help in the selection of stripping equipment, it is wise to draw profiles of the proposed stripping area along with equipment dimensions and ranges. This type of diagram will show how wide the pit can be made, what the spoil bank will look like and how each type of equipment can be used most efficiently. Some of the factors affecting the selection of key stripping units will be the tonnage of coal desired per shift, surface features, available spoil area and type of overburden.

The reserves of coal available for stripping also will play an important role in the selection of equipment. There must be enough coal owned or under lease to permit amortization of the capital investment over a reasonable period of time. It could be unwise to develop a mine with small-capacity equipment when there are ample reserves than can be recovered more economically with high-capacity units. Contrariwise, it would not be good judgment to buy big expensive machines if there are not sufficient reserves to set up a reasonable depreciation rate. Before making a decision on the type of equipment it is sound policy to have a series of meetings between engineering, operating and manufacturer's representatives to consolidate ideas.

More efficient engines for tractors, trucks and stripping machines now are available in the form of turbodiesels. A turbodiesel is a conventional diesel engine to which a turbocharger has been added to convert wasted power in the exhaust gases into useful energy. By forcing more air into the cylinders, the turbocharger makes possible more efficient burning of a greater fuel charge, thus creating more horsepower. Advantages cited for the unit include more work on the same quantity of fuel; more power, which permits better performance; and more power per pound of engine.

In any operation it is wise to consider the needs of a specific mine in relation to over-all efficiency and cost rather than merely in terms of dirt-moving capacity. Continuing growth in size and earth moving ability of new and bigger machines are the result of the industry's demand for these machines. But there also still remains the need for medium and smaller size shovels and draglines.

First cost is not the only expense involved with a stripping machine. It must be erected on the job and perhaps torn down and moved to a new site. Mounting labor costs must be given careful thought in the moving and erection costs of equipment. These two indirect costs alone may set an economic limit to the size of the unit because it is not always possible to amortize equipment during the life of an operation. Where it is not feasible to do this, medium and smaller size machines have the added advantage of low-cost moving to another location.

If the acreage or reserves of mineable coal is not large enough to justify the purchase of a large dragline or shovel, the ability to move a unit to a new site becomes an important factor in equipment selection. Mobility is particularly desirable for small or medium size companies in acquiring new coal reserves, especially in areas where large strip areas no longer are available.

Once the capacity of a mine has been decided upon through the selection of stripping equipment, other units, such as drills, coal shovels and trucks should be selected to build a balanced production cycle. After the production cycle is established, any change in one of the cycle components will upset the balance. Unless other changes are made, inefficiency will result.

It is sometimes practicable as well as economical to add flexibility to the operation by adding a small or medium size shovel or dragline. For example, a small machine sometimes can be used profitably to remove the cover in a tandem operation when a large shovel or dragline takes the major portion of the overburden.

Radio—Where mining plans call for the various machines to be working far apart or in more than one pit, strong consideration should be given to installing a radio communication system. Money spent on the radio setup frequently can be repaid in better supervision and less equipment down time. For example, time list by equipment in the pit can be substantially reduced because stripping units can report trouble immediately. Therefore repair crews and facilities can be called to the scene promptly. If the job requires parts or materials not on hand, they can be ordered from the warehouse in a matter of seconds merely by picking up the microphone and calling. If an emergency order for a part must be sent to the factory, word can be sent to the mine office and immediately relayed by phone to the factory. Frequently the part can be on the way to the mine by plane in less time than it would take to drive from the pit to the office to telephone.

Another important benefit of radio communication grows out of the fact that supervisory efficiency can be improved considerably by reducing the time needed to cover the ground to check operations. With radio, much of the routine of checking on the progress of stripping and pit conditions can be done by calling the pit, thus reducing supervisory driving to a minimum and leaving more time for planning.

Overburden Preparation

Select drilling pattern to permit most effective use of explosives.

Choose hole size to get effective distribution of explosives within strata.

Log drill holes to guide shooters in charging the holes.

Consider mixing your own explosives as a way to cut the cost of breaking rock.

Use delay shooting where vibration is problem.

Consider the advantages of shooting against a buffer where natural conditions permit.

THE GOAL in overburden preparation is to break up the material as fine as necessary to permit easy handling by the stripping unit. The ideal condition would be to have the overburden broken down into gravel-size pieces to permit low-cost handling with smaller equipment than required for moving larger-size

material or boulders. However, since the cost of drilling and shooting, including labor, to pulverize the material normally would be prohibitive, fragmentation must be looked at from the standpoint of over-all cost.

Drilling Rock

Maximum fragmentation with a minimum of labor, equipment and blasting can be achieved with high-capacity drills sinking holes in a good pattern, plus the proper breaking medium properly applied and detonated. An increasingly popular machine for drilling overburden at large-capacity mines with thick cover is the large rotary dry-type drill. Capable of drilling a 12-in hole, development of these drills reflected industry demand for a machine that would function more efficiently than the churn drill in thick, tough rock. This became much more important in recent years as more power and capacity was packed into stripping units and pressure for keeping them working at full capacity became greater. In a typical installation at a large stripping operation, a three-man crew with one large rotary dry-type unit drills 1,000 ft of 10¾-in hole and shoots better than 30,000 cu yd of overburden in a shift, permitting a dragline to move better than 1,000,000 cu yd in a month (*Coal Age*, March, 1953, p 80).

Big drill advantages also include an opportunity to use less-dense, lower-cost blasting mediums. Others are better fragmentation; less explosives per cubic yard of material broken; clean, smooth holes; and excellent stemming from drill cuttings.

The success of the high-capacity drill created a demand for the same type of drill in a lighter, smaller, more mobile and less expensive package for use at smaller operations. To meet this demand, a series of truck- or crawler-mounted drills have been designed and built for the smaller operator whose output is less than 2,000 tpd. Capable of penetrating rock at the same speed as the big units, the smaller drills are available to fit the needs of the smaller producer.

In recent years there has been a distinct trend to vertical drilling as overburden has become thicker and harder. There are several reasons for this: (1) a better chance for getting better distribution of explosives throughout the overburden; (2) more opportunity for getting explosives into hard layers where they are needed most, though some two-level horizontal drilling is achieving the same goal; and (3) reduced drilling footage where cap rock or other hard layers must be broken.

One new unit that went into service recently put down 24 holes, totaling 855 ft, in 3 hr and 36 min or approximately 238 fph. Two men drill an average of 1,200 ft of 6¼-in hole in one shift. Features of the drill include hydraulic power for all motions; infinitely variable speed rotation between 0 and 152 rpm; automatically controlled constant pressure on the drill bit; hydraulically powered crawlers that can be driven in opposite directions at the same time for fast moving; and a 55-ft mast that makes it possibe to drill a 50-ft hole without stopping (*Coal Age*, February, 1957, p 98).

When difficulty is experienced with the hole squeezing together in the portion drilled through clay or soil with a rotary vertical unit, it can be overcome by augering through the soft material and then changing to the regular roller bit. Although this requires two extra tool changes, the faster penetration of the soft material and the elimination of trouble resulting from squeezing will pay. At one Illinois operation this method of drilling resulted in a savings of $8,000 per year in bit cost.

At some mines auger stems are being used successfully with rotary dry-type machines to help bring the cuttings to the surface.

Another new machine in the crawler-mounted group cuts its own drill road and also has a built-in water-spray system to suppress fine drill dust (*Coal Age*, June, 1957 p 60).

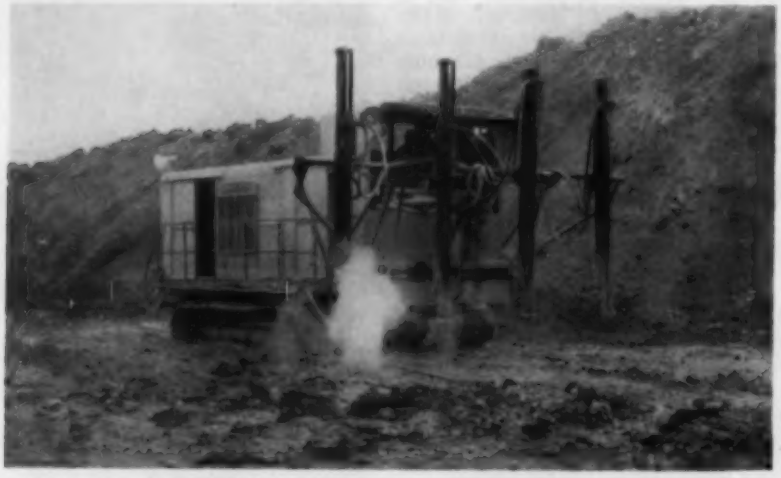
Vertical augering machines have been improved to the point where they can drill a 9-in hole in coarse-grained sandstone to a depth of 100 ft. Operating through a multispeed transmission, drill rotation can be regulated according to the toughness of the rock. Up to 600 ft of hole per shift can be drilled with this machine.

The horizontal sidewall drill remains a favorite for special applications and where the cover is comparatively thin, or where tough rock lies close to the coal. In some cases they are used effectively for two-level drilling in thicker cover. Special adjustable-level hydraulically powered sidewall units can be used effectivey to drill near a strata whose position over the coal varies up and down. They also have the advantage of easy leveling in an uneven pit. Tractor-mounted percussion units for special conditions, such

MOBILITY and high capacity are packed into vertical rotary drills designed to operate in thick, tough cover.

VERSATILITY plus fast drilling are advantages of unit mounted on wide-gage bulldozer.

SIDEWALL DRILL is effective machine where the cover is not too thick. Units are either mounted on truck bed or are self-propelled on wheels or crawlers.



SPECIAL machines for drilling thin rock between coal beds are designed to sink small holes fast. Single or multiple-arm units are available.

LOW-COST blasting mediums have reduced overall explosives costs and improved fragmentation to boost stripping efficiency at many operations.

as a thin, hard layer of rock between two coal seams should not be overlooked in seeking low-cost bank preparation.

To meet the need for a horizontal unit to drill materials too hard for auger-type machines, a rotary machine has been developed. The machine bores a 9-in hole to a depth of 60 ft without adding drill stems and has a thrust of 40,000 lb on the bit. Early tests indicate that one man will be able to drill 20 holes in one shift. Holes are said to be very straight and clean. This machine was developed primarily as a result of a need for a machine to drill hard rock near the coal.

Specialized units have been developed to drill thin layers of hard rock over the coal when the major portion of the overburden can be dug without blasting or to drill an interval between two seams. One four-unit jumbo machine mounted on a tractor drills 2-in holes on 6-ft centers and has capacity to keep pace with a 42-yd shovel that strips the main cover. (*Coal Age*, October, 1956, p 60).

Breaking Rock

Efficient overburden preparation boils down to getting the right charge of explosive in the right place. A careful study of the overburden and constant checking of field results is the answer to effective rock breaking. Sometimes a particular type of rock can be broken best with a heavy charge in large-diameter holes spaced far apart. In other cases, smaller holes spaced closer together will provide better breakage. A combination of vertical and horizontal holes produces the best results at other times.

In selecting the right explosive for a job, engineers and operators must consider the physical characteristics of the bank, its height, the material, drilling equipment available, digging equipment to be used and then select the right product to give maximum fragmentation. The drilling pattern will depend mainly on the foregoing factors.

Shale overburden usually can be blasted successfully with a single row of horizontal holes if they are large enough to permit the proper loading ratio. A single row of holes should be drilled so that the resistance of the material above the holes will roughly equal the resistance of the material between. As banks increase in height, it becomes necessary to increase the size of the hole, since holes drilled close together tend to

shear horizontally rather than exert force upward to produce the desired fragmentation. For deeper cover it is possible to use high and low horizontal holes or to combine horizontals with verticals.

Where overburden is over 50 ft, vertical drilling generally is considered best. Two-level horizontal is usually too costy and singe-level is inadequate.

Aside from varying the drilling pattern to meet the needs of individual pits, the method of distributing the charge in the hole can affect the blasting efficiency. With some types of rock, full-column loading produces the best results. With others, deck loading gives better fragmentation.

Good records should be kept for all blasts, including depth and spacing of holes, quantity and distribution of explosives per hole, type and thickness of overburden, feet of drilling, and cubic yards of material broken each day. When a satisfactory plan for shooting is worked out it should be adhered to until conditions change. The goal in blasting is to get maximum fragmentation at minimum cost and thereby permit the stripping unit to move more material with less effort.

One company has developed an electric device that automatically records the depth of the blasthole as it is drilled. When a change of strata or a significant change in hardness occurs in the rock, it is reflected in a variation in drilling pressure. The drill operator notes depth on the indicator, as well as pressure, and records both in a log book. The record for each hole is given to the blaster to serve as a guide in charging the holes (*Coal Age*, May, 1955, p 122). The operator can look at the hole log, tell how tough the rock is and then determine how much explosives will have to be used to get the best results. Drill-pressure indicators also show changes in the hardness of the strata and thus provide additional data for judging placement and quantity of charges.

Truck- or tractor-mounted mobile units are making possible variations or modifications in procedures, particularly in hillside stripping. At one property (*Coal Age*, August, 1956, p 88) the first step is to bulldoze a road at the back of the new cut to accommodate the drill. Holes on 15-ft centers are put down to depths that will yield a 50-ft bench. When shot, the material is pushed over the bank and the bench is levelled off. Then three rows of holes 12 ft apart in rows 15 ft apart are drilled starting 5 ft from the edge of the bank. The main bed in the overburden is 30 ft of sandstone underlaid by 18 to 25 ft of shale over one of the three coal beds recovered.

With a 115-ft-wide cut at another property (*Coal Age*, September, 1956, p 64) three drill roads are cut by the bulldozer. Holes are put down on 20-ft centers along the two lower roads, and on 14- to 20-ft centers along the upper road. These latter holes are 55 to 60 ft deep. The upper and middle-bench holes are decked with the charges in two zones—bottom and somewhat over half up, while the holes in the bottom section are bottom-loaded. The bottom bench is shot first, followed by the middle and top benches. Delays of 9 MS are used between rows.

A dragline operation using a mobile drilling machine bulldozes most of the softer top stratum (up to 20 ft thick) on top of 25 ft of hard material into the pit before drilling. However, a skin of soft material is left for easier starting of the vertical holes and as a blanket to reduce flying material (*Coal Age*, April, 1956, p 82). The first row of holes is started 20 ft from the edge of the bank, with 18- and 17-ft spacing for the subsequent rows to compensate for harder material.

Freedom to deck load is, as noted, a major reason for vertical drilling. There are numerous variations on the basic plan.

Overburden at one operation using a combination of vertical and horizontal holes (*Coal Age*, March, 1956, p 82) consisted of 10 ft of shale over the coal, 8 ft of lime, 6 ft of weathered sandstone, rider coal, 4 to 8 ft of sandstone (not always present), and shale to the surface. A bulldozer prepared a road at the back of the cut for a mobile drilling unit putting down 6-in holes on 15-ft centers (deck-loaded with 350 lb). Horizontal holes, 8 in, 66 ft deep, were drilled on 18-ft centers and loaded with 350 to 500 lb of 40% dynamite. Charges were set off with detonating fuse, with MS delays between vertical and horizontal rows, horizontal first. One objective of the plan was a smooth highwall for final augering.

Another mine has employed two rows of holes near the back of the cut to break a limestone layer about halfway up the bank. With the limestone broken the horizontal holes have an opportunity to heave the overburden their full length. Cover depth is less than 50 ft, with the bottom 20 ft shale followed by the lime (3 ft) and surface material. Under such circumstances, attempts to break up the hard band by heavier loading of the bottom holes can result in the charge blowing up through the overburden and losing much of its effectiveness.

Delay Shooting — Delay shooting usually will permit explosives to do a better job. At many mines milli-second delays have been used successfully to get better fragmentation and at the same time reduce concussion in the surrounding area. Reduction of vibration is especially important where stripping is being done near populated areas. The progressive relief possible with delays also permits the explosives to perform more efficiently.

As overburden becomes thicker, the problem of vibration and shock becomes greater because the thicker rock requires more explosives. In recent years, the MS-delay connector has become a valuable tool in reducing vibration—in many instances to about 25% of that with the usual shot.

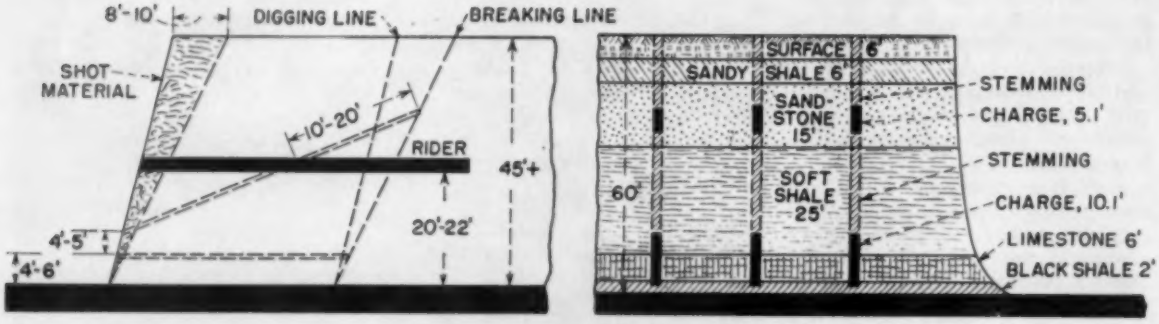
The MS connector essentially is a piece of detonating fuse with a millisecond delay built into the center. Benefits from the connectors include setting off a greater number of holes per shot with less vibration, and elimination of the hazard involved in loading a cased hole where it is necessary to charge from the drilling machine through the casing and then pull the casing up over the shunted cap wires. During this operation there is always the hazard of stray currents or a short circuit that might ground through a damaged cap wire, setting off the charge. With detonating fuse, no cap is used until this operation is completed and the machine has moved away (*Coal Age*, June, 1951, p 86).

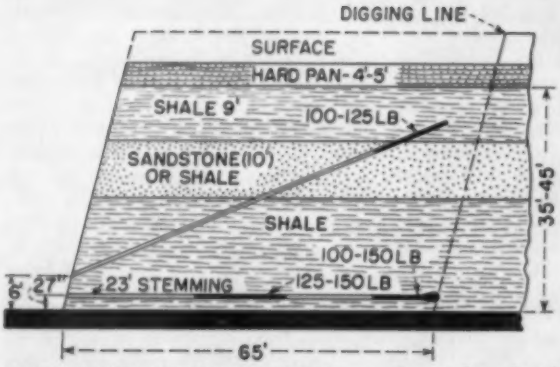
A further advantage includes a 15% speed-up in the detonation of the explosive with a reduction in the requirements. Fragmentation is as good and probably better with the reduced charge. Digging into misfires is not likely to result in an accidental explosion since caps are not used.

To reduce the quantity of detonating fuse and the number of MS delays required to set off a large number of holes, an Ohio operator is experimenting with a blasting timer that can detonate explosives at predetermined intervals. Complicated wiring is eliminated by a cable that connects the lead wires to the timer.

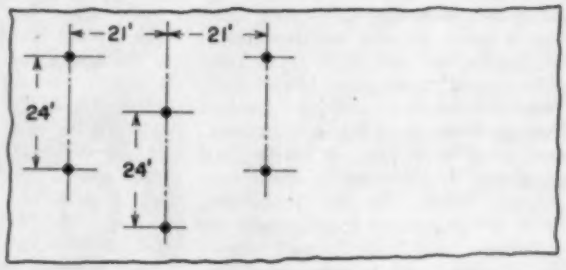
While many applications have resulted from the use of detonating fuse and MS connectors, at least one serious disadvantage of the combination is the noise and concussion caused by the detonation of the unconfined trunk line. When the shoot-

How Some Operators Tackle Unusual Shooting Problems

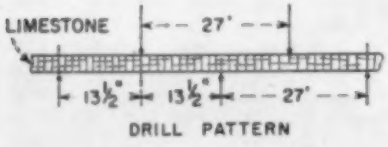


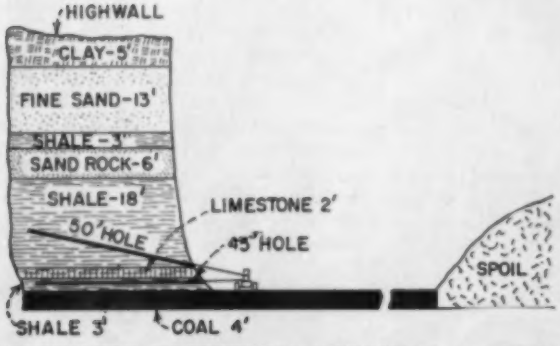


HOW DOUBLE-DECK SHOOTING can be used to break banks with hard or tough materials in the top. In the plan at the bottom, use of two holes reduced fine coal output by 10%, cut the quantity of explosive needed and enabled the dragline to work to the full depth of the holes, thus gaining 5 ft on each cut. In the system shown at the top, the explosive charge in the upper hole is brought farther toward the front of the bank and to provide sufficient resistance a layer of shot material is left.

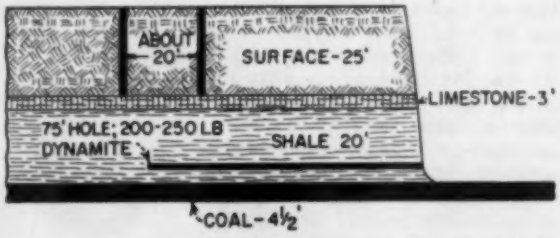


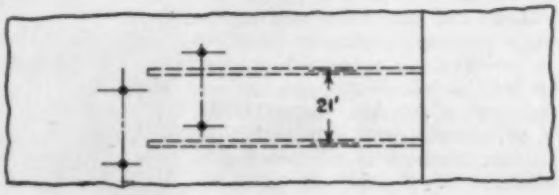
BLASTING the highwall is a tough job in this pit. Holes are drilled in diamond pattern and explosives are concentrated in hardest layers of rock. By placing separate charges in the hard sandstone and limestone layers, explosives are used most efficiently and better fragmentation is achieved. Changes in thickness of either the sandstone or limestone are watched carefully and the quantity of explosives is increased or decreased as required. Accurate logs of all blastholes are kept to serve as a guide in loading explosives.



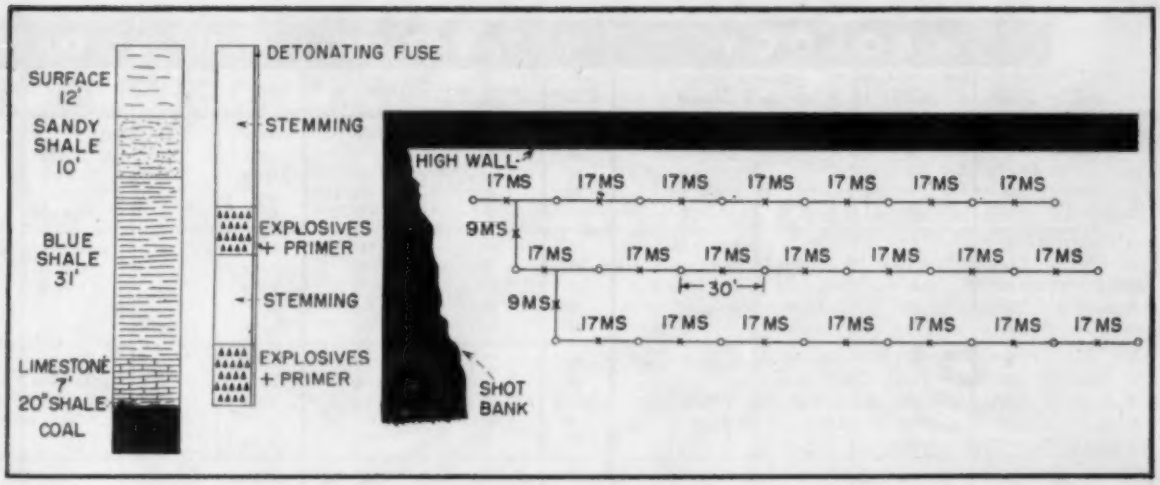


AN EXAMPLE OF HIGHWALL DRILLING in the pit with horizontal auger drill. Alternate holes are above and below the limestone.

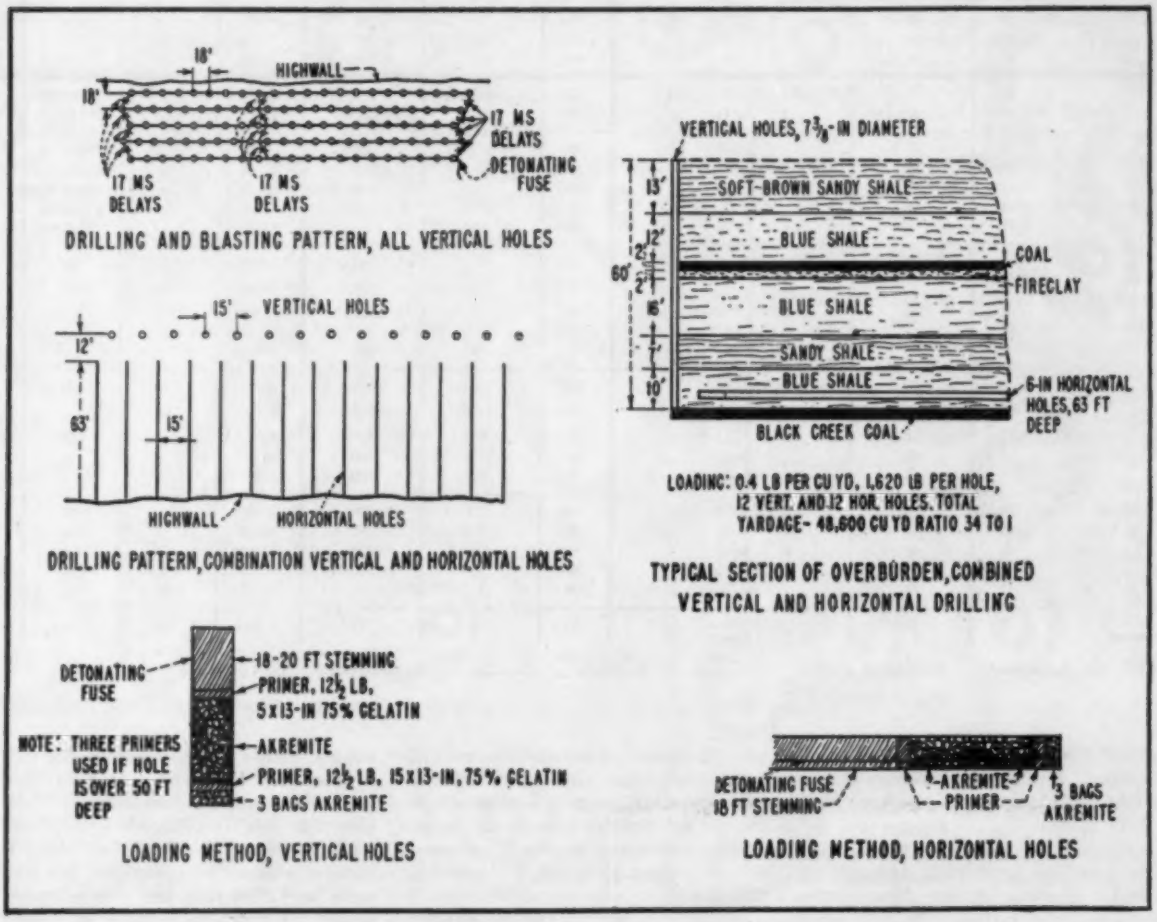




THIS RATHER UNUSUAL JOB of highwall shooting features vertical holes to the limestone to break it so the horizontal shots can heave the overburden the full depth of the horizontal holes. All shots in or near a vertical plane through the horizontal hole are fired together. The farthest-in vertical hole is slightly beyond the bottom of the horizontal hole.



TODAY'S DRILLING AND SHOOTING PATTERNS include vertical and horizontal holes or a combination of them to get the best fragmentation for easier stripping. Careful study is required before selecting a pattern.



ing operation is close to populated areas, this condition presents a problem. In one operation where the elimination of noise is highly desirable, detonating fuse is used to fire the primers. Holes are shot in groups of 11, using a single instantaneous electric blasting cap and delay caps in series 1 through 10. Only a single shovelful of dirt is required at each hole to effectively cover the few inches of exposed detonating fuse and the blasting cap.

Blasting mediums in use today include various types of high explo-

		GEOLOGY			EXCAVATION			DRILLING DATA			
	LINE NO.	COAL SEAM THICKNESS IN INCHES	AVERAGE THICKNESS OF OVERBURDEN IN FEET	OVERBURDEN FORMATION IN FEET TOP TO BOTTOM	WIDTH OF CUT IN FEET	SHOVEL SIZE IN CUBIC YARDS	PRODUCTION AV. CU. YDS./HR.	TYPE OF DRILL	DRILLING SPEED AV. FEET PER HOUR	BIT SIZE AND TYPE	BIT LIFE IN FEET
HORIZONTAL DRILLING	1	41	40-45	Ss 3-4 / S 35-40	40	2½	300	AUGER	60	6" FINGERTIP	200
	2	41	40	S 40	40	2½	275	AUGER	60	6" FINGERTIP	200
	3	58	58	L 10 / Ss 40	60	5½ D	200	AUGER	45	8" CARBIDE	250
	4	58	58	L 10 / Ss 40	100	12 D	400	AUGER	45	8" CARBIDE	250
	5	18	27	S 27	42	2½	175	AUGER	80	6" THROW AWAY	200
	6	36	35	G 20-24 / Ss 12-15	72	5½ D	250	AUGER	60	6" FINGERTIP	25-80
	7	48	44	C 5-10 / Ss 20-25 / S 10-18	90	3½	150	AUGER	75	6" CARBIDE	——
	8	48	44	C 5-10 / Ss 20-25 / S 10-18	90	12½ D	410	AUGER	75	6" CARBIDE	——
	9	52	42	C & S 0-20 / Ss & L 10-20 / S 4-10	40	3½	175	AUGER	45	6"	——
	10	42	50	C 0-30 / Ss 10-25 / S 8-10	40	3½	200	AUGER	60	6½"	——
	11	52	45	C & S 10-30 / Ss 10-30 / S 4-8	45	3½	150	AUGER	50	6"	——
	12	60	35	S 15 / Ss 8 / S 22	60	6 D	400	AUGER	100	6" FINGERTIP	200
	13	60	55	C & S 25 / L 6 / Ss 6 / S 18	75	13 D	300	AUGER	30	6"-8" CARBIDE	1000
	14	36	20	C—Ss 3-4—Sl	60	2½-1¾	——	AUGER	120	6"	——
	15	30	45	S	60	5½	330	AUGER	60	6¼"	500
	16	36	45	S—Ss	60	5½	300	AUGER	60	6¼"	500
	17	26	45	S—Ss 3—S	60	3	200	AUGER	60	6¼"	500
	18	18	40	Ss—S	50	7 D	400	AUGER	80	6¼"	1000
	19	36	45	S—Ss	60	5½	360	AUGER	60	6¼"	500
	20	42	50	Ss—S	60	5½	330	AUGER	60	6¼"	500
	21	27	30	Ss—S	40	3	150	AUGER	60	6¼"	300
	22	42	55	S—Sl	60	5½	330	AUGER	60	6¼"	500
	23	32	50	Sl	50	5½	330	AUGER	60	6¼"	500
VERTICAL DRILLING	24	36	35	C 5-8 / S 12-16 / Ss 12-14	60	4½ D	250	AUGER	50	6" FINGERTIP	35-70
	25	55	48	Ss 48	80	9 D	300	AUGER	110	6" CARBIDE	250
	26	55	48	Ss 48	80	10 D	300	ROTARY	80	6¼"	3000
	27	42	55	S 15 / Ss & S 12 / Cl 6" / Ss & S 22	50	15	600	AUGER	30	8" THROW AWAY	30
	28	42	55	S 15 / Ss & S 12 / Cl 6" / Ss & S 22	100	12 D	400	AUGER	30	8" THROW AWAY	30
	29	48	65	S 25 / Ss 40	65	5	375	AUGER	60	6" CARBIDE	300
	30	48	45	Ss 45	50	2½	——	AUGER	40	6" FINGERTIP	150
	31	52	35	Ss 35	40	3½	150	ROTARY	55	5⅛"	2700
	32	52	35	C & S 0-40 / Cl 1 Ss 12-18 / L 16-20 / S 4-8	60	12 D	385	ROTARY	50	6¼"	2000
	33	54	70	L 6 / Sl 2 / C 6 / Cl 2 / L 18-20	45	30	1000	ROTARY	40	8½"	7000
	34	54	70	L 6 / Sl 2 / C 6 / Cl 2 / L 18-20	45	17 D	450	ROTARY	40	8½"	7000
	35	42	32	C 5-8 / Ss 18-24 / S 0-5	45	18	800	ROTARY	120	6¼"	4500
	36	78	30	Ss 10 / L 8 / S 12	60	5½ D	200	ROTARY	60	6¼"	2000
	37	62	60	C 10 / L 2-6 / S 4 / L 6-10 S 5 / Ss 6-12 / Ss 8-12 / S 6-8	60	12 D	400	ROTARY	60	6¼"	1500
	38	52	50	Ss 20 / S 30	100	14 D	840	ROTARY	13	10¾"	8000-10,000
	39	48	60	Ss—S	80	14 D	800	ROTARY	18	9"	8000-10,000
	40	27	45	S—Ss	60	5½	300	ROTARY	50	4⅜"	1200
	41	36	40	Ss—S	50	7 D	400	ROTARY	60	5⅛"	800
	42	42	50	Ss—S	60	5½	330	ROTARY	45	5⅛"	800
	43	29	40	Ss—S	50	5½	330	ROTARY	45	5⅛"	800
	44	54	40	Ss—S	40	3	130	ROTARY	60	5⅛"	650
	45	23	30	Sl—C—Sl	70	12 D	720	ROTARY	60	7¾"	1400
	46	23	45	Sl—C—Sl	60	5½	330	ROTARY	60	5⅛"	800

KEY Ss—Sandstone G—Glacial Drift Cl—Coal S—Shale C—Clay D—Dragline L—Limestone Sl—Slate

* P designates Primacord SS designates delay caps with millisecond intervals MS Conn. designates millisecond connectors

sives; liquid oxygen; and newly developed lower-cost blasting agents, such as, Akremite *Coal Age*, May, 1955, p 70).

Most of the explosive manufacturers now are producing Akremite or similar blasting agents. New entries in this field include the following: (1) Nitro-carbo-nitrate which contains technical-grade ammonium nitrate instead of commercial grade. It is not cap-sensitive, and therefore a primer must be used to set it off. Speed is about 11,500 fps; (2) Unimite and (3) Methanite which contain technical-grade ammonium nitrate, coal dust and nitromethane. The nitromethane acts as a sensitizer for the ammonium nitrate and under certain conditions it is not necessary to use a primer. Speed is about 13,000 fps.

Another entry in the make-your-own group of blasting agents is made by mixing No. 2 fuel oil with prilled ammonium nitrate in the ratio of 3 quarts of oil to 100 lb of nitrate. In some instances the oil is added in a mixing plant and put up in bags and only enough is mixed for one day's supply. Other companies add the oil in the field by pouring it over the ammonium nitrate immediately before the hole is charged. One company believes that the oil should have a chance to penetrate the nitrate and therefore lets the mixture season for a definite number of hours before using it. The mixing may be done in the shipping bags.

Significant improvements in manufacturing techniques have resulted in lower prices for liquid-oxygen explosives. Having a speed of 17,000 fps, this explosive has been very useful in

DRILL PATTERN			BLASTING DATA		EXPLOSIVES RATIO		
HOLE DEPTH IN FEET	SPACING IN FEET	BURDEN IN FEET	METHOD OF DETONATION*	TYPE OF EXPLOSIVES	CU. YD. / LB. OF EXP.	LINE NO.	
36-40	10	42	P	40% Ammonia	2.8	1	HORIZONTAL DRILLING
36	12	40	P	40% Ammonia	2.5	2	
60	30	30	P	Blasting Agent + Primer	5.5	3	
60	30	30	P	Blasting Agent + Primer	5.5	4	
42	15	27	P	Blasting Agent + Primer	5.25	5	
72	15	35	P-SS	40% & LD Ammonia†	5.6	6	
90	17	44	P	LD Ammonia	5.6	7	
90	17	44	P	LD Ammonia	5.6	8	
45	15	40	P	40% & LD Ammonia	4.0	9	
60	12	40	P	40% Ammonia & Semigelatinous	2.7	10	
45	15	45	P	40% & LD Ammonia	4.5	11	
60	15	35	P-SS	LD Ammonia	2.6	12	
66	18	55	P	40% Ammonia	5.7	13	
60	15	20	P	50% Ammonia	1.0	14	
60	12	45	SS	LD Ammonia	8.0	15	
60	20	45	P	Blasting Agent + Primer	6.35	16	
60	16	45	P	LD Ammonia & Blasting Agent	4.5	17	
50	18	40	P	LD Ammonia	8.3	18	
60	15	30	P	LD Ammonia & Blasting Agent + Primer	5.0	19	
60	18	45	P	LD Ammonia & Blasting Agent + Primer	6.0	20	
60	20	30	P	50% Ammonia & Blasting Agent + Primer	5.3	21	
60	20	50	P	Blasting Agent + Primer	3.7	22	
60	18	50	P	Blasting Agent + Primer	6.6	23	
35	15	15	P-SS	Blasting Agent + Primer	2.5	24	VERTICAL DRILLING
48	15	15	SS	LD Ammonia	4.5	25	
48	15	15	SS	LD Ammonia	4.5	26	
55	32	25	P-SS	Blasting Agent + Primer	6.2	27	
55	25	25	P-SS	Blasting Agent + Primer	4.0	28	
65	15	27	P-MS Conn.	Blasting Agent + Primer	1.4	29	
45	10	10	P	LD Ammonia & Blasting Agent + Primer	2.5	30	
30	18	18	SS	Blasting Agent + Primer	3.0	31	
30	18	18	P-MS Conn.	LD Ammonia & Blasting Agent + Primer	2.5	32	
30	20	22	P-MS Conn.	Blasting Agent + Primer	3.0	33	
30	20	22	P-MS Conn.	Blasting Agent + Primer	3.0	34	
32	21	15	P-SS	LD Ammonia	4.0	35	
30	15	15	P-SS	40% & LD Ammonia	2.0	36	
60	15	15	P	LD Ammonia	1.5	37	
55	36	30	P	Blasting Agent + Primer	5.0	38	
60	27	30	P	Blasting Agent + Primer	3.0	39	
45	15	18	P	Blasting Agent + Primer	3.3	40	
35	18	18	P	LD Ammonia	3.6	41	
45	15	18	P	LD Ammonia & Blasting Agent + Primer	3.0	42	
40	18	18	P	LD Ammonia	3.2	43	
40	16	18	P	Blasting Agent + Primer	2.1	44	
28	21	22	P	Blasting Agent + Primer	4.1	45	
45	16	16	P	Blasting Agent + Primer	4.25	46	

Courtesy Explosives Dept., American Cyanamid Co.

† LD Ammonia designates Low Density Ammonia Dynamite

breaking high banks containing massive sandstone.

The characteristics of the rock and the drilling and stripping equipment control the type and quantity of the breaking medium needed and therefore no hard and fast rule can be made. In general, a dragline will require finer broken rock than a shovel, and the larger the stripping unit, the larger the size of material that can be handled economically with it.

The one operation in strip mining requiring a great deal of human effort—loading and tamping horizontal holes—has been converted to a mechanized operation at a southern Indiana mine by installing two machines to load and tamp holes. The basic principle of the machine is that a jointed tamping pole, made up of 6-ft sections connected by specially designed joints, is pushed in and pulled out by friction. The pole is stored around a square reel.

Only one man is required with these machines, and his only work consists of placing the explosives and tamping bags in the collar of the hole. Using prefilled tamping bags, one man has loaded and tamped a maximum of 28 holes in a shift.

There are certain advantages to shooting against a buffer where vertical drilling is practiced. Large chunks of rock, sometimes produced when shooting against an open face, are eliminated. The long toe that cannot be shot at all is eliminated. The drill never is required to work close to the highwall in an attempt to shoot a toe. A uniform pattern of drilling can be maintained because regardless of how crooked a pit is when first opened, adjustments can be made to produce a straight pit with a minimum of trouble.

Once a sufficient buffer is established to put the drill well ahead of the stripping machine, other benefits are possible. For example, in periods of dry weather the drill can be worked in areas of the highwall that would be very muddy in wet weather. And in wet weather the drill can be worked on ridges or high spots. If advance preparation of the highwall is needed for moving the drill, felled timber and brush can be pushed on to the buffer area and require no rehandling prior to final disposal.

The operation of the stripping unit can widen or narrow the pit to take full advantage of the machine in the spoil area available and without interfering with the drilling and shooting. Better slopes of the highwall can be made, thereby eliminating many slides that occur when there is a high, cracked overhang.

A new technique now going through the experimental stages is blow charging of blastholes. In this method the explosive is hauled to the blasting site in a hopper truck equipped with a high-pressure blower. It then is blown through a hose and packed firmly into the hole. Early results indicate that this method is very promising.

Stripping

Select stripping units to match overburden preparation capacity.

Use draglines where flexibility and range are needed.

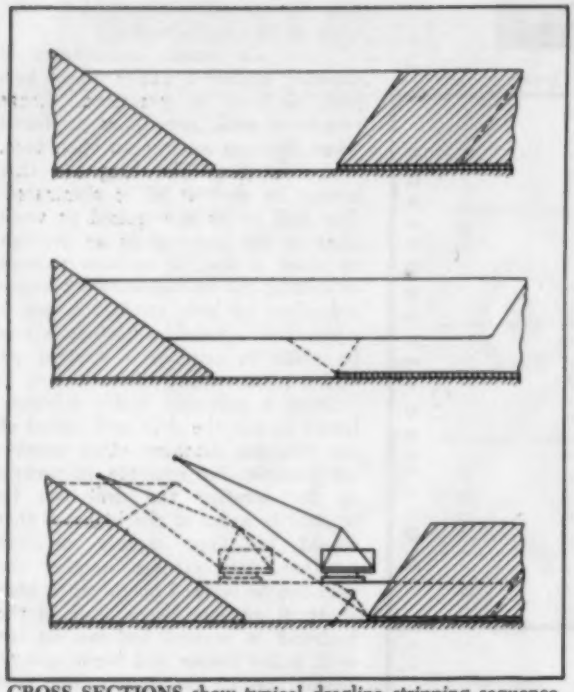
Use shovels in area stripping where seam conditions are uniform.

Consider heavy-duty bulldozers for stripping in conjunction with small or medium-size shovels.

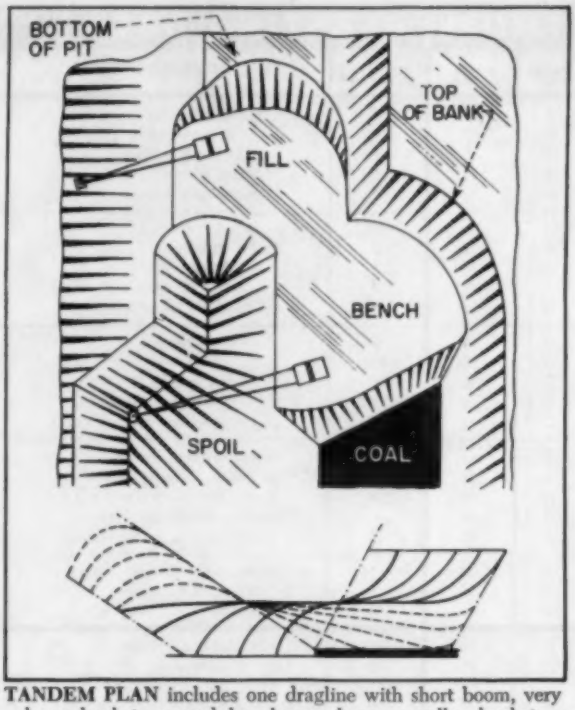
Consider diesel-powered machines where frequent moves are made.

Study machine performance to detect wasteful motions or methods.

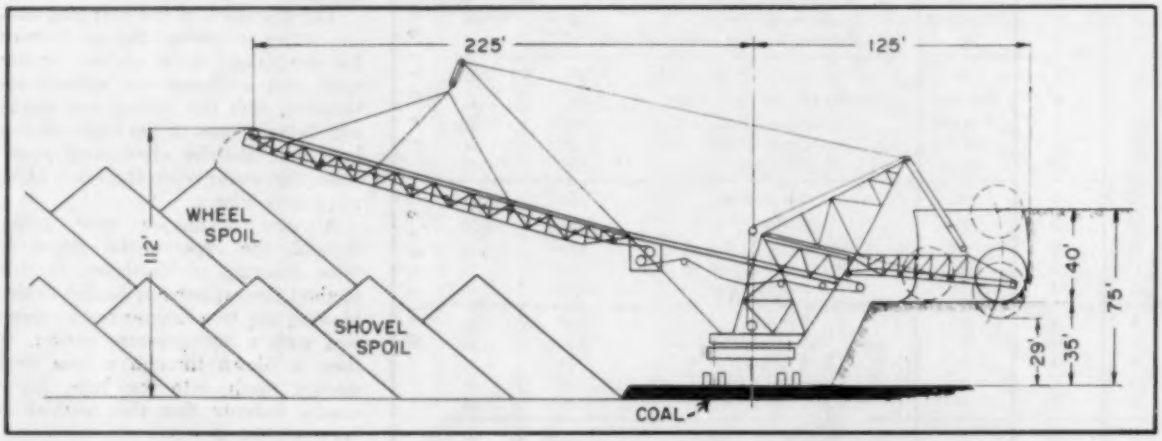
Keep cycle time to a minimum.



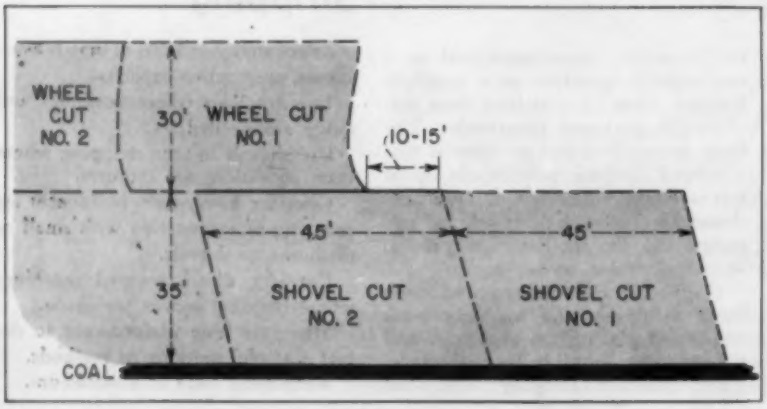
CROSS SECTIONS show typical dragline stripping sequence. Bench operation with filling of "V" is shown in center.



TANDEM PLAN includes one dragline with short boom, very large bucket; second has longer boom, smaller bucket.



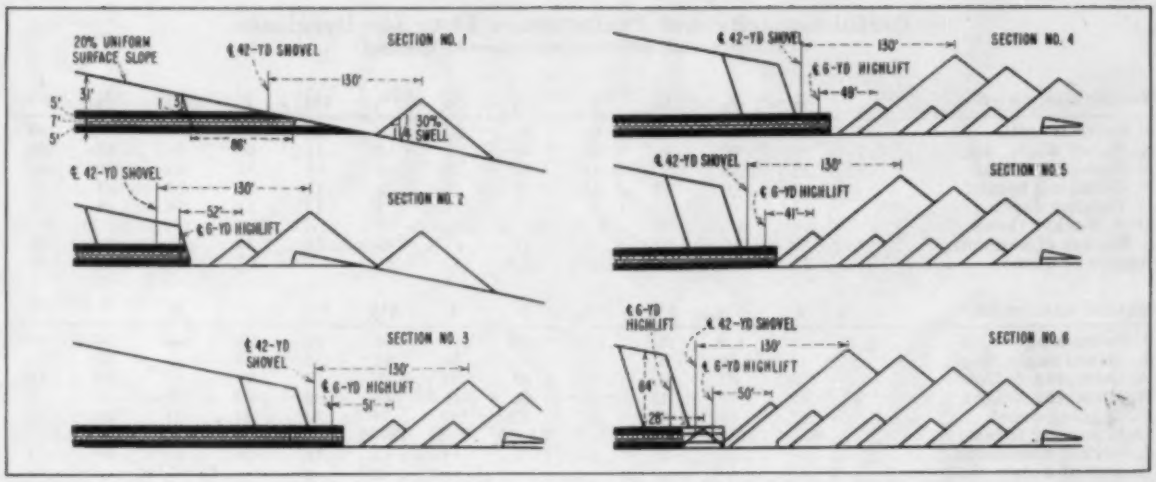
WHEEL EXCAVATOR extends stripping limit by removing up to 40 ft of soft material and discharging it 350 ft away on spoil pile. Wheel removes upper portion and casts it well beyond edge of shovel spoil.



Use bulldozer or tractor shovel for pit cleanup behind stripper.

Keep digging teeth sharp.

The goal with any stripping unit is to remove overburden as cheaply as possible. Assuming that the stripping machine is designed to work best in certain conditions, management has the responsibility of seeing that it and the operator perform as efficiently as possible. To get peak output from any unit, it must work not only continuously but in a manner that will move more material. The more full-capacity bites that a ma-



TYPICAL CROSS SECTIONS of two-seam stripping show how 42-yd shovel takes main portion of overburden on top seam and 6-yd highlift unit skims off thin layer over lower coal.

chine makes in a shift, the higher will be the output.

With a basic machine, there are a number of things that can be done to help boost capacity. These include using new lightweight, high-strength steel in the dipper to increase capacity without increasing weight; upgrading the skill of operators by training; and using auxiliary equipment on the highwall or spoil.

Box-Cutting—Opening a pit by box-cutting involves digging down to the coal and then working straight ahead to the limit of the property. By exercising care in opening a new strip pit along the property line in flat or gently rolling land it is possible to recover practically all of the coal in the tract. In some instances where a shovel or dragline is used to open a new tract along an adjoining property the first-cut spoil is placed on the surface next to the property line. Stripping then advances into the tract and the coal along the property line and under the first-cut spoil is left in place. Some operators do not consider it economically possible to rehandle spoil from the opening box cut and the regular material over the coal. As a result, the strip of coal along the property is never recovered. If a strip of coal 75 ft wide, 4 ft thick and 3,000 ft long is left in place along the property line, the loss will be about 37,000 tons.

The possibility of using auxiliary earth moving equipment, such as, scrapers and bulldozers to move the spoil from the opening box cut should be investigated thoroughly. For example, it might be possible to start at the property line and cut down 10 to 20 ft of material with scrapers and spread it in a thin layer 4 to 5 ft thick over the surface where it can be

COMBINATION of small shovel and bulldozer with rooter are effective in removing soft overburden that does not require shooting.

POWERFUL bulldozers capable of moving 600 cu yd per hour also are effective in moving overburden that requires little or no shooting.

Useful Capacity and Performance Data for Draglines

(All dimensions in feet unless otherwise specified)

Bucket size, cu yd	½	⅝	¾	1	1½	1½	1¾	1¾	2	2½	2¾	3
J. Boom length	35	40	60	50	60	50	50	80	60	50	110	60
K. Boom angle, deg	40	40	40	40	40	52	40	41	40	40	32	50
A. Dumping radius	32	35	50	43	50	35	46	65	53	46	100	45
B. Dumping height	17	20	22	24	30	36	23	47	29	23	49	35
C. Digging depth	15	18	27	21	27	18	24	42	24	24	58	17
D-A. Bucket throw	6–9	8–10	8	8–10	10–12	12–18	7–11	15–20	10–15	7–11	20–30	5–15
I. Bucket dimension	10	10	12	13	13	13	13	14	14	14	16	16
Source of data*	TL	TL	BLH	BLH	BLH	K	TL	LB	TL	TL	—	M

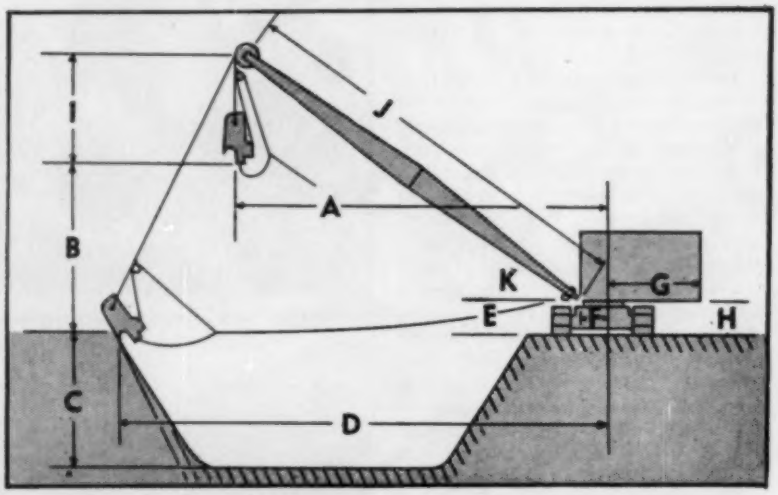
Bucket size, cu yd	3	3½	3½	3¾	4	4	4½	4½	5	6	7	8
J. Boom length	110	110	100	100	100	90	90	80	100	90	80	80
K. Boom angle, deg	37	41	34	39	43	36	41	38	37	39	41	41
A. Dumping radius	95	90	90	85	80	80	75	70	90	80	70	70
B. Dumping height	56	62	45	51	56	41	47	38	42	39	34	35
C. Digging depth	51	45	61	55	50	39	33	43	41	34	28	28
D-A. Bucket throw	20–30	20–30	15–25	15–25	15–25	15–25	15–25	10–20	15–25	15–25	10–20	10–20
I. Bucket dimension	16	16	16	17	18	18	18	18	20	20	21	21
Source of data*	LS	—	—	—	—	—	—	—	—	—	—	—

Bucket size, cu yd	10	12	13	20	23	25	26	30	30	30	35
J. Boom length	200	185	175	280	235	260	235	240	235	200	220
K. Boom angle, deg	31	32	33	35	30	35	36	35	43½	30	35
A. Dumping radius	190	175	165	250	222	234	209	218	190	191	201
B. Dumping height	81	73	70	138	98	124	116	110	136	76	98
C. Digging depth	97	87	80	120	140	111	145	102	120	120	94
D-A. Bucket throw	30–50	30–45	30–45	50–70	—	45–65	—	40–60	—	—	35–55
I. Bucket dimension	26	29	29	28	—	31	—	34	—	—	35
Source of data*	—	—	—	—	BE	—	BE	—	BE	BE	—

Explanation of Tables

*Source of data. This is a revision of a table which was based in part on data obtained from the Power Crane and Shovel Association, supplemented by data from manufacturers' bulletins. Smaller size dragline data above was contributed by the following: BLH, Baldwin-Lima-Hamilton; K, Koehring; LS, Link-Belt Speeder; M, Marion; TL, Thew-Lorain. Larger sizes from 3 cu yd and up were checked against Marion data.

Note: The above data is presented to show what representative types of draglines can do. However, data for specific models vary considerably with boom angle and length of boom. For specific earth-moving problems, the reader is advised to refer to the manufacturers listed under draglines and power shovels in the Buyers' Guide of this issue. Bulletins available will give much useful engineering information.



Refer to this drawing for symbols shown in dragline table above.

easily rehandled in subsequent cuts. The scrapers could open the area by making a cut 100 to 200 ft wide along the property line. Exact width of cut can be laid out to fit into the overall plan for the regular stripping machine. It may be desirable for the auxiliary machine to cut down an area that is two or more times the width of the cut that will be taken by the shovel or dragline.

If the resulting pile is too high to be moved efficiently by the shovel or dragline when the second cut is made, a bulldozer can be teamed with it to level and spread the material in the spoil area. Or if the material is broken finely enough, it also might be possible to use scrapers effectively in the spoil area. The cost of rehandling the first-cut spoil should be weighed against the value of the coal left in place and the effect on the cost of handling overburden over the life of the mine.

Bulldozer Stripping—As a result of more speed and power being built into today's bulldozers, they are being used more and more as stripping units. Working in pairs or in conjunction with other equipment, they are effective in moving overburden that normally requires little or no shooting.

Latest models available to the industry include single-engine units powered by engines delivering 230 hp and twin-engined models powered by two 218-hp diesels. Drawbar pull in the range of 60,000 lb or better is a feature of the new high-powered tractors. Modern tractors

Useful Capacity and Performance Data for Power Shovels

(All dimensions in feet unless otherwise specified)

Dipper capacity, cu yd	½	½	¾	¾	¾	1	1	1½	1½	1¾	2½
Special type*	—	—	—	—	—	—	—	—	HD	—	HD
X. Boom angle, deg	45	50	60	50	45	50	45	50	60	50	50
B. Boom length	17	16	18	16	17	18	21	23	22	23	26
C. Dipper handle length	15	12	15	12	15	14	18	18	17	18	20
D. Dumping height, max	14	16	17	15	13	18	19	21	24	19	24
E. Cutting radius, max height	21	18	19	19	20	21	24	26	21	26	29
G. Cutting height, max	21	22	27	22	22	26	26	30	33	29	34
J. Cutting radius, max	25	24	24	24	25	28	30	32	30	32	37
I. Cutting depth below grade	7	5	5	6	7	7	8	7	6	7	8
H. Radius of cleanup	17	14	16	15	16	20	20	21	19	22	23
Maker**	TL	LS	NW	LS	TL	LS	NW	LS	K	TL	K
Model No.	15	58	25	68	25	98	41	K360	605	72	1005

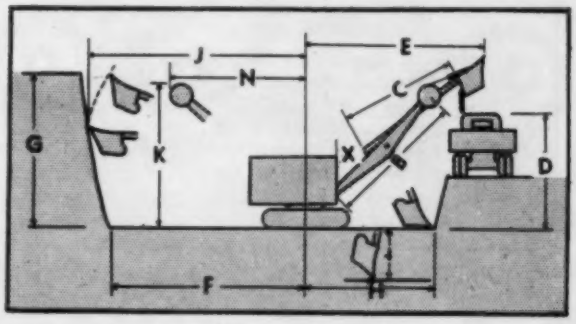
Dipper capacity, cu yd	2½	2½	3	3	3	3½	4	4	4½	5–6
Special type*	HL	—	—	—	—	—	—	HL	—	—
X. Boom angle, deg	50	45	50	45	60	50	45	50	45	45
B. Boom length	42	25	28	29	27	29	33	67	32	35
C. Dipper handle length	32	18	20	20	19	19	22	50	21	23
D. Dumping height, max	38	18	21	20	28	23	24	60	21	22
E. Cutting radius, max height	59	30	32	34	38	33	37	70	39	44
G. Cutting height, max	49	28	32	30	40	34	35	73	32	34
J. Cutting radius, max	55	36	37	38	38	38	44	82	44	47
I. Cutting depth below grade	14	9	9	8	8	8	10	4	8	8
H. Radius of cleanup	31	23	24	23	26	24	29	50	27	28
Maker**	BL	BL	—	M	LS	PH	BL	BL	PH	PH
Model No.	1201	803	—	101M	K608	1055E	1601	2400	1400	1500

Dipper capacity, cu yd	6	6	6	7	7	7	8	8	9	10	10
Special type*	—	—	—	—	—	LR	—	—	IR	—	—
X. Boom angle, deg	50	45	45	50	45	45	45	45	45	50	45
B. Boom length	38	35	38	38	37	70	39	43	55	40	44
C. Dipper handle length	23	23	23	23	23	40	23	25	32	25	27
D. Dumping height, max	23	24	24	25	25	52	27	26	39	31	27
E. Cutting radius, max height	45	45	46	44	48	74	48	49	60	48	52
G. Cutting height, max	35	37	37	37	38	65	41	40	54	46	42
J. Cutting radius, max	47	49	49	48	51	79	53	54	67	56	57
I. Cutting depth below grade	9	8	10	9	9	8	8	11	5	12	13
H. Radius of cleanup	30	30	33	30	32	45	35	35	43	37	38
Maker**	—	PH	BE	M	—	PH	PH	M	PH	—	M
Model No.	—	1600	150B	151M	—	1855	1800	181M	1855	—	191M

Table continued

(Larger Sizes)

Dipper capacity, cu yd	18	40	45	45
Special type*	—	SS	—	SS
X. Boom angle, deg	45	45	49	45
B. Boom length	105	113	120	113
C. Dipper handle length	69	70	79	64
D. Dumping height, max	73	76	80	71
E. Cutting radius, max height	112	107	120	106
G. Cutting height, max	92	104	107	100
J. Cutting radius, max	120	132	131	127
I. Cutting depth below grade	—	—	—	—
H. Radius of cleanup	69	76	71	76
Maker**	—	BE	—	BE
Model No.	—	1050B	—	1050B



Refer to this drawing for symbols in shovel table above

Explanation of Tables

Note: For details pertaining to a specific earth-moving problem, consult the manufacturers listed under Power Shovels in the Buyers' Guide section of this issue. Bulletins supplied by shovel manufacturers present complete data including performance ranges for boom angles varying from 40 to 60 deg. These bulletins also show mechanical details of the units and specify power source including diesel engines, diesel-electric units, gasoline engines and electric motors equipped with Ward-Leonard or rotating controls.

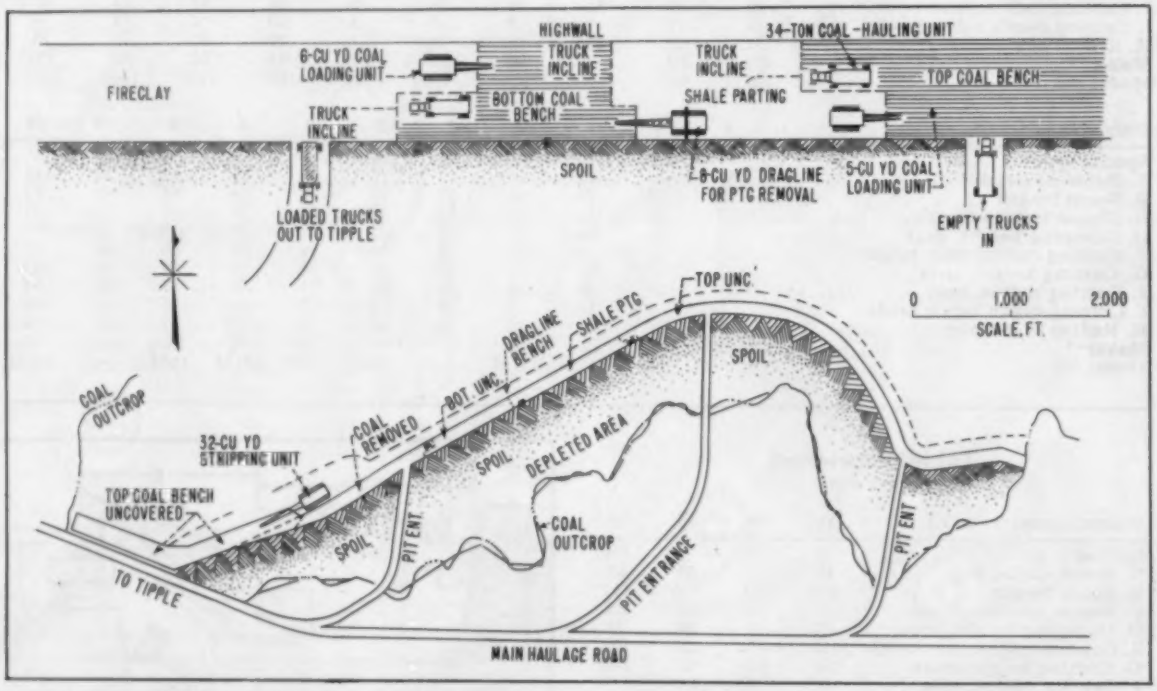
*Key to symbols—HD, Heavy Duty; HL, High Lift; IR, Intermediate Range; LR, Long Range; SS, Stripping Shovel.

**Key to symbols—BL, Baldwin-Lima-Hamilton; K, Koehring; LS, Link-Belt Speeder; M, Marion; NW, Northwest; PH, Harnischfeger; TL, Thew-Lorain; BE, Bucyrus Erie.

Note: The above data is presented to show what representative types of shovels can do. It is based in part on a table prepared by the Power Crane and Shovel Association, and supplemented with manufacturer's data supplied for this issue of the *Coal Age* Mining Guidebook.

VERSATILE tractor scraper can cut down 30 to 35 ft of cover, haul it several hundred feet where casting is not feasible.

BACKFILLING and leveling can be done at rate of 600 cu yd per hour with today's powerful bulldozers.



WELL PLANNED pit layout and mining sequence are important factors in getting full output from all equipment.

are available with either torque converters or direct drive.

Where stripping is assigned to bulldozers alone, a minimum of two should work together. For efficient material handling, an average of not more than 35 ft of cover should be moved and the terrain should be gently rolling or hilly to permit easier movement of overburden. Pushing should be 90 deg with the outcrop after the initial cut is made along the outcrop and the bulldozers should work together, one following the other and slightly overlapping the path of the leading unit to pick up side spillage.

After the pit is filled sufficiently, the dozers should start pushing to the main spoil area away from the highwall. As succeeding cuts are made and the highwall gets steeper, it will be necessary for the dozers to rehandle as much as 20% of the material. To establish the highwall, the bulldozers should cut parallel to the outcrop and dig down to the coal. If hard material is met, it should be drilled and shot fine enough so that the bulldozers can move it easily.

Another possible combination for stripping up to 35 ft of softer material is the small shovel and the bulldozer. With this type of setup the bulldozer works across the outcrop and takes off 10 to 12 ft of loose material—sometimes up to 20 ft (*Coal Age*, January, 1954, p 82). The shovel is used to remove the more solid material down to the top of the coal.

At another operation in Pennsylvania two big, powerful bulldozers are teamed with a diesel-powered 2-cu yd shovel and a 4-cu yd diesel dragline to move up to 60 ft of cover

CONTINUOUS OPERATION with highwall auger units is achieved by storing coal. Unit at left discharges coal onto ground for loading later at convenient time. Spare trucks at right permit full-shift augering and continuous operation.

(*Coal Age*, March, 1957, p 82). Each dozer works with one of the strip machines in a separate pit, two shifts per day. The bulldozers not only cut down a portion of the bank but push a great deal of the material into the pit where the stripping units can handle it easier. They also push a large portion of the material in the spoil to a point beyond the range of the stripping units.

After a sufficient area of coal is uncovered, the shovel can double as a coal-loading unit while the bulldozer continues to remove the top layer of cover or performs utility or cleanup work. The shovel-bulldozer setup is not designed for high output but can be used effectively where cover is relatively soft and a large capital expenditure is not feasible.

Scraper Stripping—It is possible that conditions may change after a stripping unit has been purchased and it may be desirable to go to a higher bank. However, the available shovel or dragline may not be able to handle the overburden in one pass. Consequently, rehandling or two passes are needed. Or the unforeseen problem of a shortage of spoil area may develop and partial haulage may be necessary. Under these conditions the high-speed rubber-tired tractor-scraper has gained acceptance as an efficient auxiliary machine to move the top portion. Once loaded, the unit can haul spoil several hundred feet at little added cost. If the overburden is compacted, it is good practice to supplement the scraper units with a rooter that can be taken over the ground ahead of the scrapers to break up the ground.

Tractor-scraper units can be used to make an opening cut and working bench for a dragline (*Coal Age*, June, 1949, p 94), or remove up to 35 ft of overburden (*Coal Age*, August, 1953, p 74). The number of tractor-scrapers needed for the job depends on how much of the total cover can be moved by the scraper and how much overburden must be moved to uncover the coal needed each day. For example, five tractor-scraper units aided by a rooter have removed 30 to 35 ft of cover at an operation working to a 75-ft highwall and producing 1,700 tpd of strip coal. Shovels remove the lower portion of the overburden. A very worthwhile advantage of the scraper method of handling spoil is that little extra work is necessary where backfilling and leveling are required.

In some present day deep anthracite pits where available draglines cannot handle overburden in one pass, the high-speed scraper has been well accepted as a primary unit in removing the top layer of overburden. Thus the dragline burden is eased. Some advocates say that it costs less to move overburden with scrapers than with a shovel and trucks.

A push-loaded scraper will load faster and will carry greater payloads because the load is heaped better and packed tighter. To get the most from scrapers, the loading area should be planned so that the units load on a down grade; haul roads should be well maintained; and the dumping area kept in good condition so the load can be released while traveling at a fair rate of speed.

Good preventive maintenance practices to follow in scraper operation include keeping good cutting edges on the scraper at all times; and holding the apron at proper height while loading to avoid damage or distortion. A mis-shaped apron permits load leakage on to the haul road with possible resultant tire damage. A light channel welded across the top of the scraper front end will prevent the sides from bulging and will not hinder loading.

The development of the hydraulically operated ripper mounted on a large bulldozer has increased the range of the scraper. The shales and soft rock that previously resisted loading by scrapers or ripping with old-type rippers or rooter are now successfully loosened. In one pass the hydraulic unit with three arms spaced at 53 in loosens a total width of 9 ft to a depth of 12 in. The cost of this work, depending on hardness and stratification of the rock, should not exceed 2¢ per cu yd.

Shovels and Draglines—Shovels are available in a wide range of designs and capacities to meet all stripping conditions. For example, a 3-cu yd shovel with a 28-ft boom and 20-ft dipper handle can cut to a 32-ft height. A 45-yd shovel with a 120-ft boom and 79-ft dipper handle can cut to a height of 107 ft. The 60-yd shovel which went into service in 1956 has a 150-ft boom and can pile spoil 97 ft high. In between these two extremes are a series of units to meet all the conditions where shovels are applicable.

Draglines also are available in a wide range of sizes to meet varying conditions. A 2¾-yd dragline with a 110-ft boom can dig to a depth of 58 ft and spoil to height of 49 ft above the bottom of the bench on which it is working. A 35-yd unit with a 220-ft boom can dig to a depth of 94 ft and

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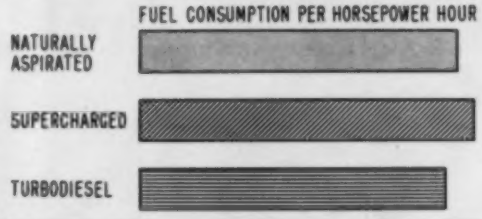
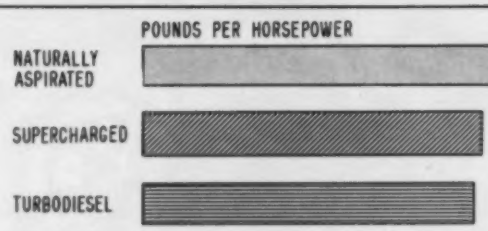
1. GREATER FUEL ECONOMY is possible from Turbodiesels than from either naturally aspirated or mechanically supercharged engines.



2. MORE HORSEPOWER without increased size, can be produced by a Turbodiesel than from a naturally aspirated engine of equal displacement. This means better performance without increasing the size.

3. REDUCED ENGINE WEIGHT per horsepower is made possible with Turbodiesels. Where weight is an important factor, this means additional gains in payloads.



pile spoil 98 ft high above the tub. In between these sizes are a host of machines that can handle nearly any assignment.

Big shovels in the 33- to 50-yd range usually work to a maximum of 70 or 80 ft of cover. Removal of overburden between 9 and 50 ft thick by a 45-yd shovel costs about 45% of what it would cost to do the same job with an 8-yd shovel; in overburden between 9 to 90 ft, about 77% of the cost with an 8-yd shovel; and in overburden between 50 and 80 ft, about 25% more than an 8-yd shovel working in a bank 50 ft high. Big shovels also recover coal that would be left by smaller shovels or would have to be auger or deep mined. However, it must be remembered that the area to be stripped must contain enough coal to warrant the capital expenditure for a big shovel.

Flat coal seams and steep slopes cause overburden thickness to increase rapidly as successive cuts advance into the hillside. To meet these difficult conditions, the large walking dragline is most useful because of its long dumping range. The stripping life is increased in proportion to the dumping range of the dragline, and maneuverability of the unit is advantageous in working sharp angles and inside curves. The disadvantage is that it must have a suitable base and this is sometimes difficult to provide in rocky overburden. This factor must be considered in choosing between a dragline and shovel.

Operating Stripping Units

To get the maximum return from the investment, the stripping machine must be kept working as much as possible, and with no lost motion. To assure the best from shovels or draglines, some companies have installed recorders to indicate work time, angle of swing and the number of swings per shift. The records are studied to detect recurring delays.

Another important factor in good machine operation is reducing cycle time to a minimum. The time consumed in loading, swinging, dumping and returning for a new load must be kept to a minimum. Proper planning of spoil areas goes a long way toward keeping the swing arc as short as possible as the machine rotates between pit and spoil area.

The key to fast loading is a well-prepared bank and the finer the material the faster it can be loaded. But it must be remembered that there is an economic limit to spending money for explosives to break the rock into fine pieces. Each operation must be examined carefully before a decision is made as to how much fragmentation is economically feasible.

Upping Dragline Efficiency — Machine output can be maintained at a high level if the operator handles it in a manner to get the best digging efficiency with minimum power consumption. It is sound practice to analyze the work of the dragline to determine if the operator is getting the most out of the machine.

Proper working of the digging face offers the best opportunity for achieving maximum production from a dragline with a minimum of power consumption and wear and tear on the machine. Slicing material off in layers will give more output than working in trenches. However, a "key" or trench cut along the highwall line frequently will ease the rest of the work. The dragline bucket should be loaded as quickly and hoisted as nearly vertically as possible to keep power consumption at a minimum. Poor operation, such as digging on a slope near the machine and lifting the loaded bucket approximately 45 deg with the vertical may consume up to 42% more power.

Quick loading and immediate hoisting will move the most yardage. By keeping the digging area under the boom, dividends will be reaped in greater output. The bucket should be filled while traveling two or three

bucket lengths and then hoisted immediately. Every effort should be made to get a full bucket in the short travel but if it is not completely filled, it is best to lift and swing the load. By hoisting the bucket as soon as it is loaded, dirt pileup in front of the machine will be avoided and the danger of drag rope wear will be eliminated.

Side pulling with the boom overheats and wears swing clutches, puts unnecessary wear on the flanges of the boom-point sheave and may result in a twisted boom. This should be avoided to keep maintenance down.

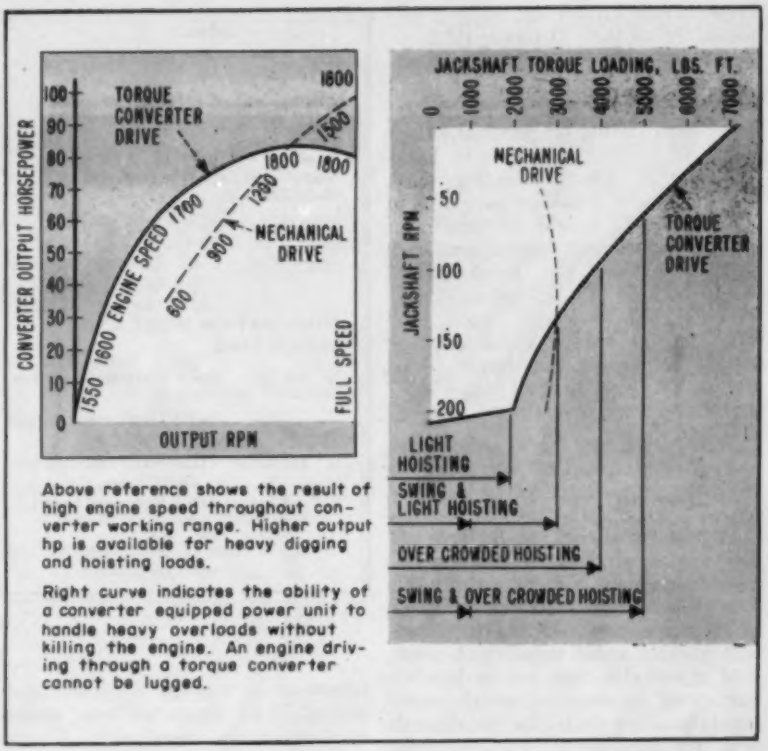
Bucket Maintenance — Proper handling on the job, coupled with good maintenance procedures, will keep bucket maintenance to a minimum. Among the bad operating practices to be avoided are striking the bucket against a solid object to loosen sticking material; dropping the bucket, especially with the teeth down; slapping the bucket against the boom while hoisting; and pulling the drag-bail socket into the fairlead.

Bucket teeth take a beating and must be kept sharp for good digging. Spare sets of teeth should be kept on hand for frequent changing to permit worn units to be built up with hard-surfacing materials. Under no conditions should teeth be permitted to become badly worn.

Small cracks develop in the bucket from time to time as a result of accidental abuse. These should be repaired as quickly as possible to prevent big repair bills later. Many companies find it profitable to buy a minimum of two buckets for each dragline so that bucket maintenance can be done on the regular work shift without reducing dragline output. When repairs are needed the bucket is changed on the off-shift, or with a minimum of delay if the dragline works around the clock. Two buckets kept in good condition and used alternately will last longer than buckets bought one at a time and used continually until worn out.

Shovel Operation—As with dragline loading, the bank should be removed in slices in shovel work, also. The thickness of the slice should be such that the dipper will be filled as it reaches the top of the bank. It is usually good practice to dig the top half of a high bank first. This keeps sloughing into the pit to a minimum and avoids lowering of the dipper to the bottom each cycle. Consequently, cycle time is speeded up and output is increased.

Load indicators also are gaining in favor to show the operator when the



Above reference shows the result of high engine speed throughout converter working range. Higher output hp is available for heavy digging and hoisting loads.

Right curve indicates the ability of a converter equipped power unit to handle heavy overloads without killing the engine. An engine driving through a torque converter cannot be lugged.

What Is a Torque Converter?

The torque converter drive has become increasingly popular in recent years in diesel-powered machines. Torque converters increase the operating efficiency and life of equipment working under adverse conditions. Units with particular performance characteristics, operating within given drive ranges, have been designed for individual types of equipment. For example, converters for crawler tractors must be designed to take into account that the machines operate near the governed engine speed with maximum horsepower output over a wide range. In direct contrast, power shovel operation requires maximum power over a limited speed range.

The torque converter itself is a relatively simple mechanism. But its operation frequently is confusing. Basically, the torque converter is like the fluid transmission of a modern automobile. It transmits torque from one member to another through a fluid.

Unlike a fluid coupling in which input torque is always equal to output torque, the torque converter multplies torque. All other principles of the fluid coupling apply to the torque converter. A torque converter has a stationary reaction member in the fluid circuit. This serves as a fulcrum point upon which the fluid works as a lever to produce a reaction torque under certain conditions. This torque, together with the input torque, results in a greater output torque.

In the torque converter, the impeller is the same as in the fluid coupling, although its physical construction is different. It is still connected to the engine and acts as a hydraulic pump. The runner, or turbine, serves the same function as in the fluid coupling, but its construction is different. It has one, two or three rings of blades—thus the terms one-, two- or three-stage torque converters.

Blade angles and the angle at which they are set within each of the members determine the relative value of reaction torque that will be added to input torque under various operating conditions. Maximum reaction to torque is provided when the turbine is stalled. It decreases as turbine speed increases, thus always automatically making available the exact torque required for any change in load conditions.

dipper is fully loaded and ready to be hoisted (*Coal Age*, October, 1953, p 80). The operator can be trained to hoist and swing as soon as a full load is indicated on a meter in his cab rather than relying on personal judgment. An indirect benefit from load indicators is less overloading and therefore fewer breakdowns.

Short moves should be made to maintain an efficient digging position. Digging beyond the boom point should be kept to a minimum. When working with too much reach, too much time is lost crowding and retracting. Sweeping the dipper back and forth to level off spoil causes side strains and wear on the boom, dipper stick and dipper.

Pit Cleaning

Pit cleanup should not be done at the expense of reducing the operating efficiency of the stripping unit. It must be remembered that the goal in stripping is to keep the stripping unit working at full capacity. A great deal of valuable time can be lost by attempting to clean up widely scattered boulders that can be cleared from the coal by an auxiliary unit, such as a bulldozer. The money spent on an auxiliary dozer and operator in most cases will be more than repaid by an increase in output of the stripping unit and therefore in coal output.

However, it usually is more economical to have the stripping unit scale down loose material on the highwall as stripping is done than to trim the wall later with the coal-loading unit. In some cases, particularly where the cover is thick, it may be impossible for the coal shovel to reach loose material and therefore some coal will have to be bypassed until the next cut is uncovered. This makes a ragged pit and may result in some coal being lost under the spoil bank.

Stripping Thick Cover

Where extra thick cover is constantly present, the big dragline is the most popular machine. However, the successful application of the 60-yd shovel shows that the shovels can not be counted out in the thicker cover. Since going into service in February of last year, the 60-yd giant's performance has been very satisfactory. Output has been at a rate well over 2,000,000 cu yd per month while working to 80-ft banks.

The question of what is the top limit for dipper size has not yet been answered. A 55-yd shovel now is in operation in western Kentucky and several 70-yd giants are now under construction for operation in Illinois and Indiana.

There is no fixed rule regarding equipment application and many combinations of machines are doing yeoman duty. For example, a shovel may be teamed with a dragline in a tandem operation. In this type of setup, the drag works ahead, taking the upper section of the overburden and leaving the remainder for the shovel. The percentage of material to be handled by each unit depends on the capacity of each and the stripping conditions.

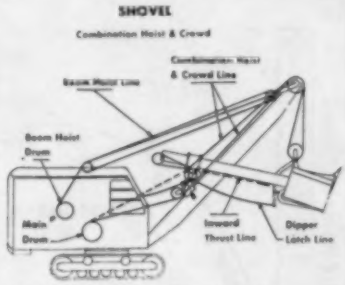
Various other combinations are being used in tandem operations. Where there is a fairly thick layer of soft material at the surface, tractor-scrapers and bulldozers can work on the highwall and cut down a sizable portion of the overburden. Auxiliary equipment also can be used effectively on the spoil pile to permit stripping units to work to higher banks. The choice of equipment depends upon the job and the quantity of material to be rehandled. Where auxiliary units work on the spoil bank, they frequently do a great deal of leveling so that final reclamation or backfilling is not too costly.

If only one machine is desired for stripping under consistently thick cover, the dragline usually gets the nod. Improved electrical controls and bigger motors have made it possible for the drags to work to higher banks and move more cover per hour. The result is more material moved at no greater cost than when working to lower banks. Where shovels would be working at extreme range or working limit, rehandling materials, or working in two lifts the dragline definitely offers advantages. Since the 60-yd shovel has proven its ability in 80-ft banks, big shovels can not be ruled out in the thicker cover, however.

Whenever possible, thick cover should be removed by casting. However, there are limiting factors, such as, spoil area available and range of the stripping unit. If the coal seam lies flat, is of average thickness and brings only an average sales price, it usually is not profitable to haul spoil. But if the coal is steeply pitching or is extra thick and the sales price is high enough, spoil haulage is feasible as a means of increasing the stripping range. Spoil haulage is most common in the anthracite area and is being carried on to a lesser degree in the bituminous.

Rugged high-powered end-dump trucks lead in spoil haulage, with tractor-scrapers and rock wagons moving a respectable portion of the material. In many cases, spoil is hauled to worked out sections of the pit, while in others such as hillside stripping, it is hauled to ravines or below the outcrop. The wheel excavator with its stacker belt also may be classed as a spoil hauler as well as a stripper since it carries spoil beyond the limit of the ordinary stripping unit.

The wheel excavator has been developed for use in the United States to cut the cost of moving material in 50- to 85-ft highwalls. The three ob-



COMBINATION HOIST AND CROWD LINE

⅝" and ¾"	6x25F Preformed Lang Lay, IWRC 6x25F Preformed Regular Lay, IWRC
⅞" and Larger	6x25F Preformed Lang Lay, IWRC
*1" and Larger	6x41F Preformed Lang Lay, IWRC

*Where sheaves or drum diameters are less than 22 times rope diameter.

INWARD THRUST LINE

⅝" and ¾"	6x25F Preformed Lang Lay, IWRC 6x25F Preformed Regular Lay, IWRC
⅞"	6x25F Preformed Lang Lay, IWRC
1" and Larger	6x41F Preformed Lang Lay, IWRC

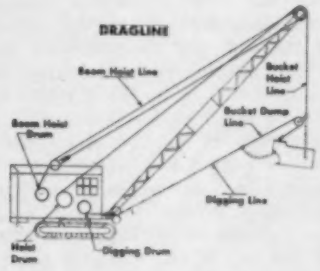
DIPPER LATCH LINE

6x36G Preformed Regular Lay, Fiber Core
8x19E Preformed Regular Lay, Fiber Core
7x19 Preformed Aircraft Cord sizes under ¼"

BOOM HOIST LINE

6x25F Preformed Regular Lay, IWRC

WHAT WIRE ROPES are recommended for



DIGGING LINE (LOAD LINE)

5/8" and 3/4"	6x25F Preformed Lang Lay, IWRC 6x25F Preformed Regular Lay, IWRC
7/8" to 1 1/2"	6x21F Preformed Lang Lay, IWRC
1 5/8" and Larger	6x25F Preformed Lang Lay, IWRC

BUCKET HOIST LINE

5/8" and 3/4"	6x25F Preformed Lang Lay, IWRC 6x25F Preformed Regular Lay, IWRC
7/8" to 1 1/8"	6x25F Preformed Lang Lay, IWRC
1 1/4" and Larger	6x41F Preformed Lang Lay, IWRC

BUCKET DUMP LINE

	6x25F Preformed Lang Lay, IWRC 6x25F Preformed Regular Lay, IWRC

BOOM HOIST LINE

	6x25F Preformed Regular Lay, IWRC

Courtesy Macwhyte Co.

use on draglines and shovels

jectives in using the machine are: (1) to permit handling overburden up to 85 ft thick, placing the spoil far enough away to avoid slides; (2) to cut the cost per cubic yard below that possible with conventional machines of equal size and capacity; and (3) to leave any overburden not moved by the machine so low in height that capacity of the accompanying shovel or dragline will be increased.

Operating experience with American wheel excavators show that they can move 1,700 cu yd of overburden per hour and spoil it a maximum distance of 388 ft from the digging point (*Coal Age*, March, 1955, p 58). Power costs per yard are the same as a large shovel and are considerably less than draglines.

A significant saving in drilling and blasting cost is possible with the wheel excavator where it can be used. For example, one Illinois operator was able to shorten blastholes by 30 to 40% while eliminating the problems of hole squeezing and casing through sand. At the same time bit cost was reduced considerably.

At another wheel operation, a wheel strips and spoils 10,000 cu yd per shift, moving 25-30 ft and leaving 30-35 ft for a 33-yd shovel (*Coal Age*, July, 1956, p 60). Cuts taken by both machines are 45 ft wide, but the wheel-excavator cut is offset from 10 to 15 ft from the shovel cut to provide a bench that prevents spillage of the softer top material onto the uncovered coal where the shovel would have to rehandle it.

The narrow bench left by the wheel provides another advantage since the shovel can work to a nearly vertical face on the lower bench, instead of having to shape a sloping highwall to prevent sloughing of the softer top material.

Two Seam Stripping

In some instances, both in anthracite and bituminous, two seams fairly close together can be mined profitably where one alone would not be a profitable venture. Or, recovery of a thinner second seam, since overburden removal is necessary to get at the main seam anyhow, provides a low-cost additional source of tonnage. The method of mining and equipment used for multiple-seam stripping depends upon the dip and thickness of the beds; the lay of the land, whether gently rolling, flat or hilly; and the type of rock above and between the seams.

In anthracite mining, multiple-seam stripping usually is on the pitch. Overburden may be moved by any of the standard types of stripping equipment, including draglines, shovels and draglines, or shovels alone. Spoil haulage is common practice.

Where there are flat or nearly flat seams, overburden can be moved by a specially designed shovel (*Coal Age*, August, 1954, p 64); two draglines plus an auxiliary shovel (*Coal Age*, July, 1955, p 56); or a shovel and dragline (*Coal Age*, January, 1953, p 84). The choice of equipment in each case was made to get the best results under the conditions.

The specially designed shovel strips two seams simultaneously from one position in gently rolling country. Both seams are thin and are separated by 16½ ft of rock. Working on the lower seam, the shovel uncovers a 50-ft strip on each level while working to banks up to 60 ft above the upper seam.

The two draglines and auxiliary shovel are used in flexible setup in gently rolling country to mine two seams separated by 3 to 10 ft of limestone. Where banks range between 50 to 70 ft in thickness, the two draglines work in tandem, and where cover is thinner they work separately. The limestone interval between the two seams is drilled with percussion units and the broken material is cast to the spoil area by the coal shovel on the off shift.

The shovel and dragline were teamed to mine two seams separated by about 40 ft of rock in hilly country. Operating procedure is to remove the lower seam back to the outcrop of the top seam, using the shovel to make a working bench for the dragline which completes the cut. Next the shovel removes part of the cover and makes a bench on the upper seam for the dragline, which strips to a 40-ft bank. After this coal is removed, augering is done to complete mining in the upper seam. The next step is to recover the lower seam, leaving a 90-ft highwall. Augering to a depth of 175 ft in the lower seam is the final stage in mining at this property.

The newest two-seam stripping operation is the River Queen mine where a 55-yd shovel chews up overburden at the rate of 100,000 cu yd in 24 hr. Designed originally as a 70-yd unit, the shovel was cut to 55 yd so that a longer handle could be used for the two-seam stripping job (*Coal Age*, June, 1957, p 84).

Time Studying

Time studies can be used effectively to improve machine performance and thereby cut costs. A careful study or group of studies often can result in getting more useful work per hour and boosting the actual working time of the machine. Hence machine capacity is increased.

Industrial engineering techniques are being applied more and more to help mine management increase operating efficiency. And this practice is becoming more widespread in strip mining. A time study method designed for stripping shovels can be

very simple, but the benefits can be large.

To get the most from a shovel time study, conditions under which the unit works must be studied carefully. Shovel performance can be affected directly or indirectly by width of coal pit or strip pit, width of haulage berm, water in the pit, haulage units and depth of overburden.

The type of overburden and how easily it can be dug is especially important. A series of time studies and a careful analysis of the results will show when the most economical point of overburden preparation has been reached.

Time studies for shovels can be divided into two types. The simplest is a daily record of how many swings the machine makes and the length, in degrees of arc, of each swing. This information is obtained automatically by mounting a recording device, sometimes called a swing recorder, on the shovel. This device has a spring clock which pulls a roll of graph paper past a moving recording needle. The recording needle is synchronized with the movement of the machines swing gears and records each swing on the roll of graph paper.

This type of study indicates when no useful work is being done—a straight line appears on the recorder roll. To provide management information on these delays, shovel operators should be given daily delay forms on which to check off the cause. If these forms are designed properly, all the operator need do is place an X in the proper place to pinpoint the cause of the delay.

From the recorder sheet and the operator's delay sheet, engineers can make a complete report of how much time was spent digging, how much time was lost in delays and the number of swings.

More detailed time studies involve going over each motion of a shovel with a fine-tooth comb. The goal with this type of study is to control or improve such elements as swing, crowd, hoist to spoil area and filling the bucket, and then to blend them into an efficient cycle. Once a standard cycle is set up, continuing studies can help maintain the standard. If efficiency drops, management knows it immediately and can take the proper corrective steps.

Better bank preparation, changes in digging techniques, redesign of various parts of the machine, changes in dipper and tooth design or revision of electrical equipment are some of the major items that may be desired as a result of analyzing time studies.

Augering

Since the highwall auger was introduced to the industry, it has grown to the point where it is producing in the neighborhood of 7,000,000 tons a year. When teamed with stripping equipment, such coal-recovery drills have permitted stripping to be done to higher banks. The combined cost of auger coal and strip coal from the higher bank can be made to equal or better the cost when stripping alone is done under thinner cover.

Coal produced by augering usually is dry, clean and has a good proportion of lump sizes. However the proportion of lump usually decreases as the augering depth increases. Where the seam is overlaid by a layer of high-ash coal, selective mining can be practiced and clean coal produced without preparation.

If augering is to be done as part of the stripping operation, it is wise to make preparation as stripping progresses. Care should be taken in blasting so that the highwall will be left unshattered and stable. A highwall slide can endanger the lives of men or result in serious damage to the auger in addition to causing a loss in production. A clean well-drained pit of suitable width for auger operation should be left as stripping progresses. It is much more economical to anticipate the use of the auger and make the necessary preparations as part of stripping than to do it later. It also is desirable to auger as soon as possible after stripping is completed and while the highwall is in the best condition. If there is coal remaining beyond the augering limit, solid blocks of coal should be left to permit access for future deep mining. The size of block to be left depends upon the thickness and type of cover, and the thickness and the strength of the coal.

Augering usually is done by drilling single holes to the desired depth with a unit that takes nearly the full seam height. However, for seams more than 5½ to 6 ft thick, it is best to use a smaller auger and double drill, preferably overlapping the bottom hole into the top. Staggering top and bottom holes is another method. The depth to which augering is carried out depends to a great extent on the coal thickness, whether the seams roll or are flat, and whether they are strong enough to stand after penetration and not foul the auger. Distance between holes also depends on the strength of the coal and the overlying rock.

Early augers were quite large and required pits up to 90 ft wide. Success of these models led to the development of small ones for use in thinner coal and narrower pits. Today's augers are available in diameters ranging from 16 to 52 in, and are capable of producing as much as 800 tons of coal per shift. To permit greater flexibility in operation, augers are available with conveyors that permit coal to be discharged on either side of the unit. A three- or four-man crew usually handles all the work involved in the augering and is supplemented by a group of truck drivers.

Equipment requirements for augering depend upon the application. For example, if the auger works in conjunction with stripping a bulldozer and trucks will be all that will be needed. Service and maintenance trucks used for the stripping equipment can take care of the auger. If augering is done independently of stripping, either in abandoned strip pits or in areas where no stripping was done, a small shovel and service facilities probably will be needed. The shovel will be needed to provide a working bench along the outcrop or help the bulldozer clean old pits.

At one West Virginia operation where a 48-in auger recovers 400 tons per shift, three men perform all the work connected with augering. One man operates a bulldozer to move the auger to new drilling sites and to clean the pit in the augering area. The other two men operate the auger and add or remove auger sections.

Coal from the auger is discharged onto the ground adjacent to the highwall. When a good size stockpile has been built up, the coal-loading shovel moves in at a convenient time and loads it (*Coal Age*, September, 1956, p 64).

Among the latest newcomers in auger design is a self-moving 48-in unit that works in a mountaintop pit only 26 ft wide. Self positioning with three hydraulic positioning jacks permits the unit to be moved fast and easily to a new hole site (*Coal Age*, September, 1956, p 72).

Three augers, two full time and one spare, are used at this property to recover coal that could not be stripped because of steep hills that would permit spoil to roll or slide downhill and damage vital mine installations.

REMOVING FINE DIRT from the coal surface before loading can be done quickly with a combination scraper sweeper.

PREPARING for easy loading is a job often handled by hand-pulled wagon drill that sinks small holes for explosives.

GOOD CLEANUP along the edge of the spoil bank with tractor shovel is one way to prevent loss of coal.

FLEXIBILITY in coal loading where more than one pit is in operation is an advantage of truck-mounted loading shovel.

Production of 150 tpd with only six men, including truck drivers, is achieved with a 24-in auger. The company uses trucks for overnight storage to get full-shift operation. Four trucks are used regularly by the two drivers. While they shuttle back and forth between the pit and cleaning plant, the elevator operator spots empty trucks. When a truck is filled it is driven from under the elevator and parked headed toward the preparation plant. When a driver returns with an empty truck there is a loaded one waiting for him (*Coal Age*, December, 1956, p 54).

A new entry in the auger group is a twin-head machine capable of boring two holes at the same time. The unit breaks out the small pillar between the two holes and thereby increases recovery. Capacity is boosted and as a result, thinner seams that previously could not be mined profitably now may be recovered.

Coal Loading

Balance coal loading capacity with stripping capacity.

Use bulldozer, motor grader or power broom to clean top of coal before loading. Employ hand cleaning where power units cannot remove impurity from irregular seam.

Consider special machines for loading thin seams.

Speed loading rate by blasting or breaking hard seams.

SHOULD COAL be blasted before it is loaded? The answer to that question can be found only after making a thorough study of the conditions at a particular mine. And even then the conditions may change from time to time so that no hard and fast rule can be set up.

Where the coal is of average thickness and hardness, explosives used in breaking the overburden usually will loosen the coal sufficiently so it can be loaded easily without being blasted. But sometimes it is too hard to be broken this way or the nature of the overburden may prevent it.

At other operations, it is necessary to drill and shoot the coal in a separate operation. Self-propelled combination machines made up of drills, compressors and brooms are gaining in favor for this work. Either one or two drill arms are mounted on these units to put down holes in a minimum of time. The power broom is

used to sweep the top of the coal before holes are drilled in the coal and is disengaged from the power unit when the combination machine is used for the drilling job. Sometimes a hand-pulled wagon with a gasoline-powered drill is satisfactory.

Still another tool for preparing thin seams for loading is the pinning machine. This unit travels over the coal on crawlers, dropping a weighted, pointed steel pin or pins that pierce the coal and fracture it enough to permit easy loading. The advantage of this machine is that the coal can be broken as quickly as it could be drilled, the cost of explosives is eliminated and a minimum of fines is produced.

Coal Cleaning

Preliminary cleaning before loading, where desirable, can be done by tractor-scrapers, bulldozers, graders, rubber-mounted scoop loaders or power sweepers. If there are any clay veins in the coal or the top of the coal is very irregular, it may be necessary to remove part of the dirt by hand. Hand cleaning, however, is expensive and should be avoided where possible.

Loading Methods

There are available for the loading job a variety of units with capacities and design features to fit any pit condition. First consideration in choosing a coal-loading machine is to get the right capacity. This means matching loading capacity to the stripping capacity. In some cases it might be desirable to have some excess capacity in the coal shovel in case of hard digging, or transportation or tipple delays that jam up empty trucks at the loading point. By loading trucks rapidly, with an oversize shovel, the haulage cycle can be put back to normal in a minimum of time. Thus the plant can be fed uniformly with few surges.

If the coal seam is thin, it is well to consider the horizontal-thrust shovel or the skimmer unit, either of which moves the dipper parallel to the bottom while loading. These units have the advantage of scooping up a wide channel of coal without disturbing the bottom. In other instances, a conventional shovel equipped with a specially designed dipper is a satisfactory unit for loading thinner seams of coal.

If the coal seam is split into two or more parts by several feet of rock, the specially designed dipper on a conventional shovel may work out better. The top layer of coal can be scooped off and then the same shovel can be used to remove the rock covering the lower portion of the seam. If the coal loader cannot be spared for the rock job, the regular stripping unit can be used on the off shift to remove the thin layer of rock.

When the coal is more than 2 or 3 ft thick, but is extremely hard, a divided dipper can be used effectively to limit the size of lump that is delivered to the truck and therefore to the preparation plant.

Where two-shift operation of the preparation plant is not desirable and the coal is thin, top efficiency from the loading and hauling units can be achieved by heaping the coal to one side of the pit on the off shift so that loading time will be as low as possible on the regular shift. The loading shovel thus can load a truck faster and coal will be carried to the tipple at a faster rate.

Increasing Coal Recovery—The importance of recovering all the coal that is uncovered cannot be overemphasized, particularly where the seam is thin. If by careless operation of the coal-loading shovel 3 in of coal is left on the bottom over an area of one acre, the loss will be about 450 tons. If 10 acres of coal are stripped in a month, the resulting total loss will be 4,500 tons. At a sales price of $4 per ton, this amounts to $18,000 per month.

If working completely to the bottom results in much over-shooting or in too much loss of time, and there is considerable coal involved, a bulldozer may be assigned to accompany the loading shovel. It can rip up the bottom coal—with the aid of scarifying arrangements if necessary—and keep it pushed up to the loader with a minimum of digging into the bottom and at a cost still representing a considerable saving over leaving the coal or delaying the loading. If a washing plant with sufficient capacity is available, some bottom material can be tolerated with either shovel or bulldozer cleanup. If a washer is not available, more care is required, but it still is possible under many conditions to increase recovery without undue contamination.

Another place where good loading procedure pays off is along the outer edge of the coal where it is in contact with the spoil. If a 6-in strip of coal is left along 1 mi of it in a seam of coal 60 in thick, the loss will be about 528 tons of coal. At $4 per ton, this will be $2,112. To provide a solid vertical edge and prevent losses such as this, one company developed a marking machine that shears through the coal, marking the loading limit for the shovel and leaving a smooth vertical wall on the bench. Estimated savings were about 200 to 400 tons per acre.

Transportation

Match size of trucks to size of loading shovel.

Select truck with shortest turning radius possible for easy turning in the pit.

Consider torque-converter truck where steep grades will be encountered.

Consider hydraulic retarders for controlling truck speed on long steep downgrades.

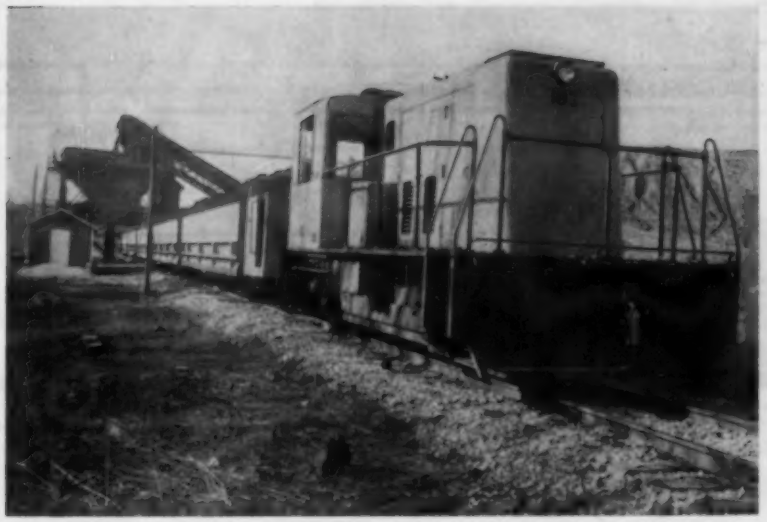
Investigate possibility of combination of truck and rail haulage where haul is long, topography is favorable and reserves ample.

GOOD HAULAGE TODAY depends upon modern equipment installed and used in a workmanlike manner. The rugged end-dump truck and semi-trailer are the favorites for coal haulage, with the overland belt from pit to preparation plant an added starter in the transportation field. To pick the most suitable equipment or combination of units for the best haulage results, a careful analysis must be made of the job to be done.

The largest available unit does not always mean a lower cost per ton because final truck selection is based on many factors including production, pit width, type of roads, grades, distances and size of loading shovels. Wherever possible, the size of the haulage unit should be matched to the size of the loading shovel. For example, a 5- to 7-yd shovel works well with a 40-ton truck and a 3- to 4-yd shovel teams well with a 25-ton hauler. A good rule of thumb is to use trucks with four to five times the dipper capacity of the shovel.

Overall height of the truck should be such that it makes a good target for the loading shovel. Length should be a minimum and width a maximum so that the shovel loading cycle can be kept to a low value. Ability of a truck to turn around in cramped quarters in as short a time as possible and get under the shovel without delay should be considered to avoid traffic congestion.

Coal-hauler size runs up to 50 tons in anthracite, and up to 70 tons or



RAIL HAULAGE with diesel locomotives offers advantages where topography is favorable and ample reserves are available.

better with tractor-trailer units in bituminous. Power is supplied by engines up to 400 hp. In the past 5 yr trailer weight has decreased, and payload and speed have increased by 25 to 30%.

Torque converters make for smooth truck operation, less lugging and lower maintenance. They also have made it possible for loaded trucks to climb steep grades, thus shortening haulage routes. In some cases, a 48-ton truck with torque converter can haul coal at up to 30% less per ton-mile than a 37-ton truck with a standard transmission on the same route.

Air starters have been used effectively on large coal haulers to eliminate all batteries except the 6-v units for headlights. Starters are operated by compressed air supplied at 100 psi from a storage tank on the tractor. Trucks can stand idle for 4 or 5 days and there still is enough air in the tanks to start them.

Hydraulic retarders are now available for controlling the speed of trucks on long steep downgrades. The unit also acts as a governor. Mounted on the drive shaft of the truck, the device is designed so that when the shaft speed increases, the retarder resistance automatically increases at a much faster rate. Therefore any tendency of the truck to run away is curbed by the retarder which piles up resistance very rapidly when the truck's speed tends to increase. A control valve by the driver regulates the degree of braking available by controlling the oil passing into the retarding device. Aside from slowing the truck, the device is said to save tires, fuel, time and brake lining.

Where the haul is over 3 or 4 mi, the topography is favorable and sufficient coal reserves are available, the use of a field station and rail haulage to the preparation plant is worthy of consideration, particularly since the advent of the small diesel locomotive. With this type of setup one man can load a trip of cars, haul it to the preparation plant, dump it and return to the field station in a minimum of time. A minimum of trucks are needed to shuttle back and forth between the pit and the field station. Consequently, truck maintenance costs also are lower and fewer men are needed for operating and servicing trucks. A further advantage is that road maintenance will be lower.

An added starter in the transportation field is the overland belt system that carries coal from portable bins near the pit to the cleaning plant (*Coal Age. August,* 1954, p 64). Where the land is gently rolling and stripping can be carried out in a wide area, the overland belt offers the following advantages:

1. Eliminates the cost of building and maintaining long high-speed haulage roads.

2. Permits movement of larger tonnages with fewer and/or smaller trucks.

3. Permits recovery of belt after the property is worked out. Roads cannot be recovered.

4. Reduces the manpower required for maintenance of trucks.

5. Requires a smaller supply inventory and less garage space.

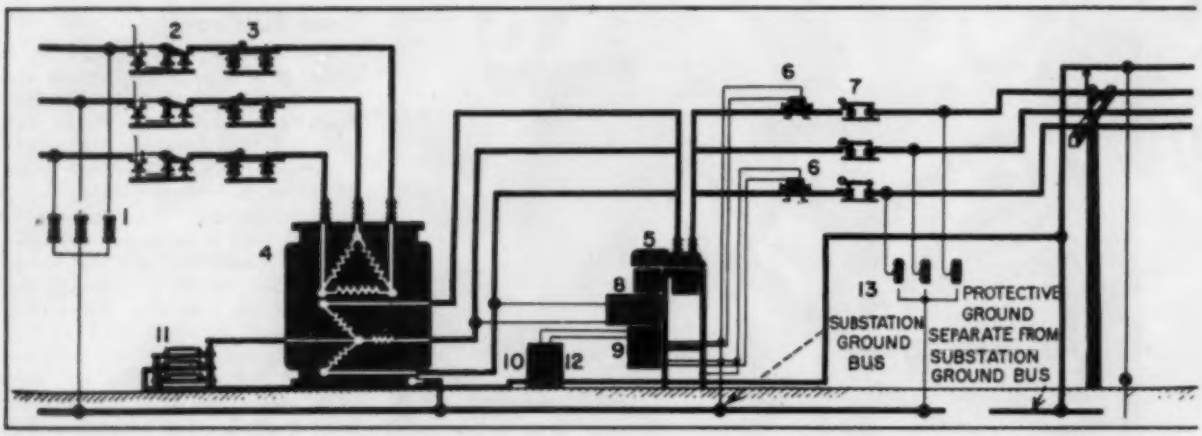
Road Building

Where haulage is completely on roads, it is of vital importance that a good running surface be provided. Main roads should be built with wide road beds and have good alignment to permit trucks to run at top speed. All curves beyond the gentlest should oe superelevated. Roads should be planned well in advance and when fills are needed to get the proper grade, they should be built up well ahead of the time they are needed. Fills should be compacted as they are made and topped off with one or more feet of rock that will serve as a road base. After this material is compacted, a top layer of crushed rock should be added and compacted. This top layer usually is applied in several layers and compacted between each. Material used for the top layer includes Nos. 3, 4 and 6 crushed limestone, 2-in slag or red dog. One or more road graders, depending on the length of road to be maintained, are used at most operations to keep the running surface smooth. Roads should be sprinkled regularly during the dry, dusty season not only to maintain good visibility but also to keep dust out of truck engines and moving parts, thus reducing maintenance needs to a bare minimum.

Grades should be avoided as much as possible to keep power requirements down. For example, it takes twice as much force to move a 20-ton load up a 5% grade as on the level. Where grades must be negotiated, stepped-type roads can be used to advantage. This type of road involves alternate stretches of level road and short, comparatively steep rises. Therefore less clutching is required in trucks equipped with standard transmissions and there is less lugging on the up grade and overspeeding on the down grade. Constant shifting and lugging results in reduced life for engine, transmission and clutch.

Entrances to the pit should be one way if possible. Turning and backing large haulage units takes time and thus reduces haulage efficiency. Proper design of turn-ins can eliminate this problem.

In winter, roads should be cleared of snow before trucks start to operate. This will prevent formation of slippery conditions caused by compacted snow. A motor grader, started several hours before trucks begin to travel, should be able to clear an average snowfall. If there is a severe storm, bulldozers should be added to help move the snow off the haulage roads.



1 LIGHTNING ARRESTERS—for protection against high-voltage surges on the high line.
2 DISCONNECTING SWITCHES—for disconnecting substation from high line.
3 BA FUSES—for short-circuit protection.
4 TRANSFORMER—may be either three single-phase units or a single three-phase unit.
5 OIL CIRCUIT BREAKER—for short-circuit and ground-fault protection on distribution lines.
6 CURRENT TRANSFORMER—for use with type CO over-current phase relays.
7 DISCONNECTING SWITCHES—for disconnecting distri-

Components of an Open-Pit

Power

Buy power at highest possible voltage to get the most favorable contract possible.

Provide adequate protection against ground faults.

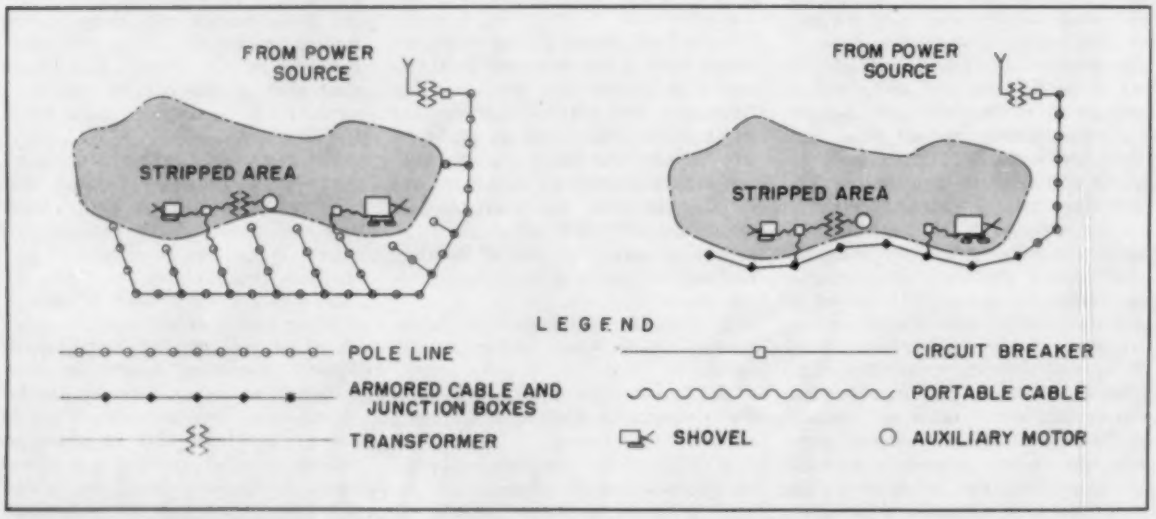
Use Type SHD cables for portable service, preferably in 1,000-ft lengths.

Consider parallel operation of portable substations at large operations.

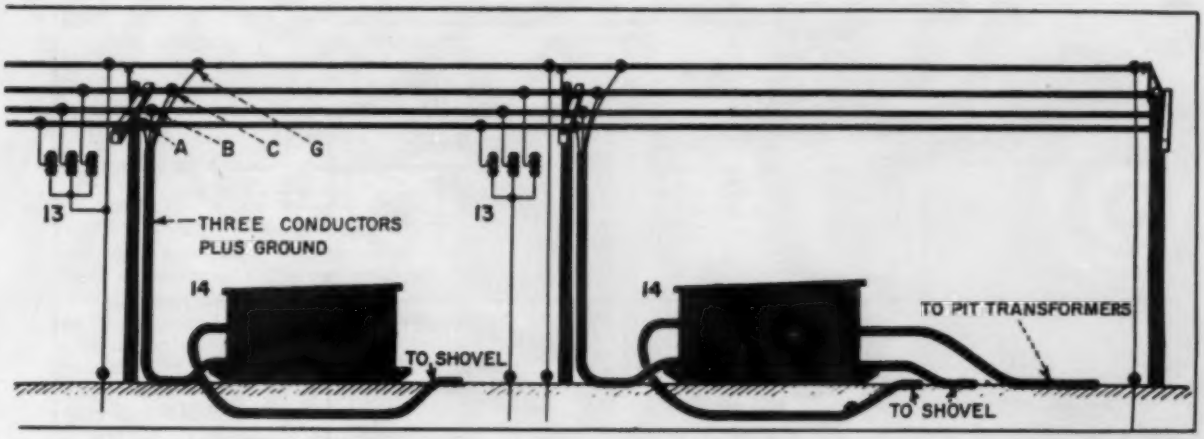
Consider less expensive special-type mine power cables for exclusive use between breaker skids on the highwall.

THE INCREASED LOAD demands of higher powered machines requires more and more thought in planning the distribution systems supplying pit power. In laying out a distribution system three primary factors are involved. First, the system must be able to supply the equipment without objectionable voltage regulation from an operating standpoint and at the same time stay within reasonable economic limits. Second, the system must provide adequate protection for personnel and equipment. Third, the units in the system must be adaptable to relocation to keep up with the change in the load requirements.

Public utility companies supplying the energy for operating strip mine equipment are faced with the problem of greatly increased demands on their systems. Many times they have



TODAY'S power distribution systems at strip mines include both lateral pole lines and armored cables.



bution lines from substation.

8 CAPACITOR TRIP DEVICE—providing a source of energy for tripping oil circuit breaker.

9 TYPE CO PHASE RELAYS—for short-circuit protection.

10 TYPE CO GROUND RELAY—for ground-fault protection.

11 GROUNDING RESISTOR—for limiting ground-fault current.

12 CURRENT TRANSFORMER—for use with type CO ground relay.

13 LIGHTNING ARRESTERS—for protection against high-voltage surges on distribution lines.

14 PORTABLE SWITCHHOUSES

Power Distribution System

been able to handle this increased capacity by switching to higher voltage transmission lines. Mining companies using large quantities of energy can get a more favorable contract if they receive power at the higher voltage. To do this the customer must purchase a transformer substation capable of reducing the voltage to that required for the portable equipment.

Frequently energy is now received and metered at 33,000 or 66,000 v. Thus the user builds the higher voltage transmission lines from the metering station to the portable substation units located near the area to be stripped.

Voltage may be reduced in either a one- or two-step transformation. With one-step transformation, primary mine distribution usually is 2,300 or 4,160, with 6,600 and 7,300 volts coming into the picture as a result of heavier demands imposed not only by the increase in machine use but by higher horsepower per machine. In two-step transformation, the "super-primary" voltage usually is 13,000. Permanent transformer stations may employ either single- or three-phase transformers, with a trend toward the latter. A number of strip operations also employ semi-portable stations completely or to supplement permanent stations. Commonly called unit substations, they are based on three-phase transformers. Typical ratings are 1,500, 2,000 and 2,500 kva, with the top usually 5,000. Normally these stations include lightning arresters, circuit breakers, ground-protective equipment and other central and protective facilities.

Primary distribution systems generally fall into two general classes:

1. Pole-mounted high lines.
2. Cable systems.

A third version is a combination of pole line or lines and cable line or lines. Pole-line practice is largely standardized, with a main line a maximum of 1 mi in advance of the pit and parallel to it. From this main line, pole-line laterals at intervals of 1,200 to 1,500 ft are run to the pit, terminating in switchhouses which supply auxiliary transformers for low-voltage equipment, and also supply the cables on the larger high-voltage equipment. As the pit moves across country, the laterals are shortened at intervals until the pit approaches the main line, which then is moved to restart the cycle. Cables on the equipment usually are 1,000 ft long. Thus, with a lateral spacing of 1,200 to 1,500 ft, equipment can operate freely between laterals with enough cable to spare to permit terminating laterals some distance back when shortening is necessary.

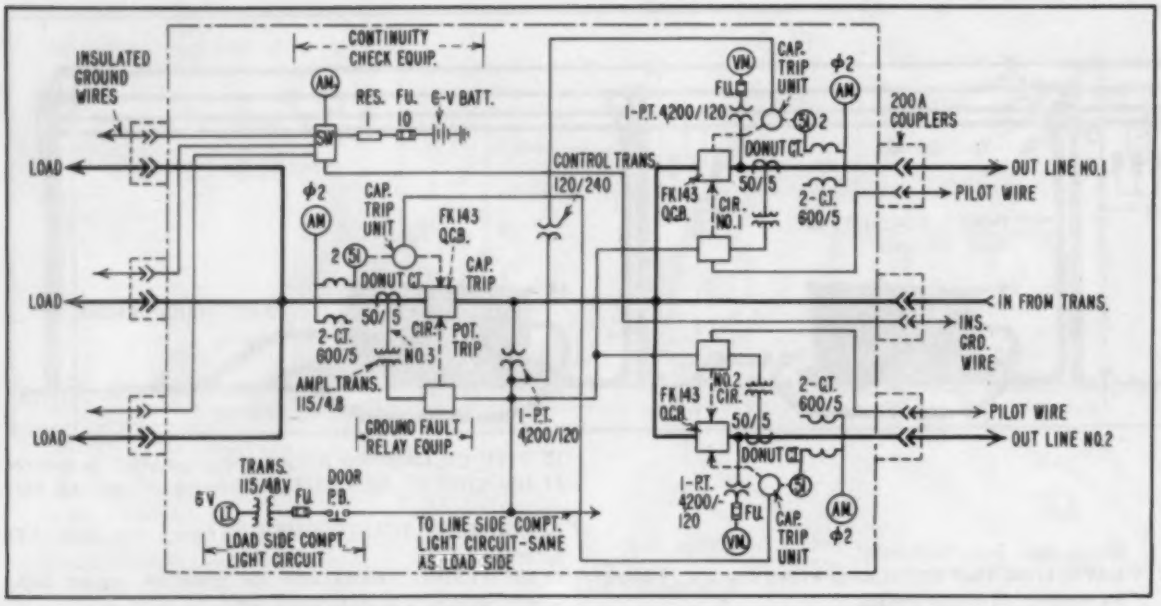
The latest development in strip mine power systems is operation of substations in parallel (*Coal Age*, October, 1956, p 60). At the present time two skid-mounted 1,500/1,725-kva substations are in operation, with plans for adding a third unit. The pit power distribution system is entirely by portable cables and multi-conductor plugs and sockets.

Special mine power cables are used between breaker skids. The cable is similar to the Type SHD portable shovel cable in that it has a copper basket weave over individual conductors. It differs in that it has smaller ground conductors and a thinner outer jacket. This type of cable was bought at a saving of approximately of 46%. It is used exclusively on the highwall and seldom, if ever, will it be necessary to move it while it is energized.

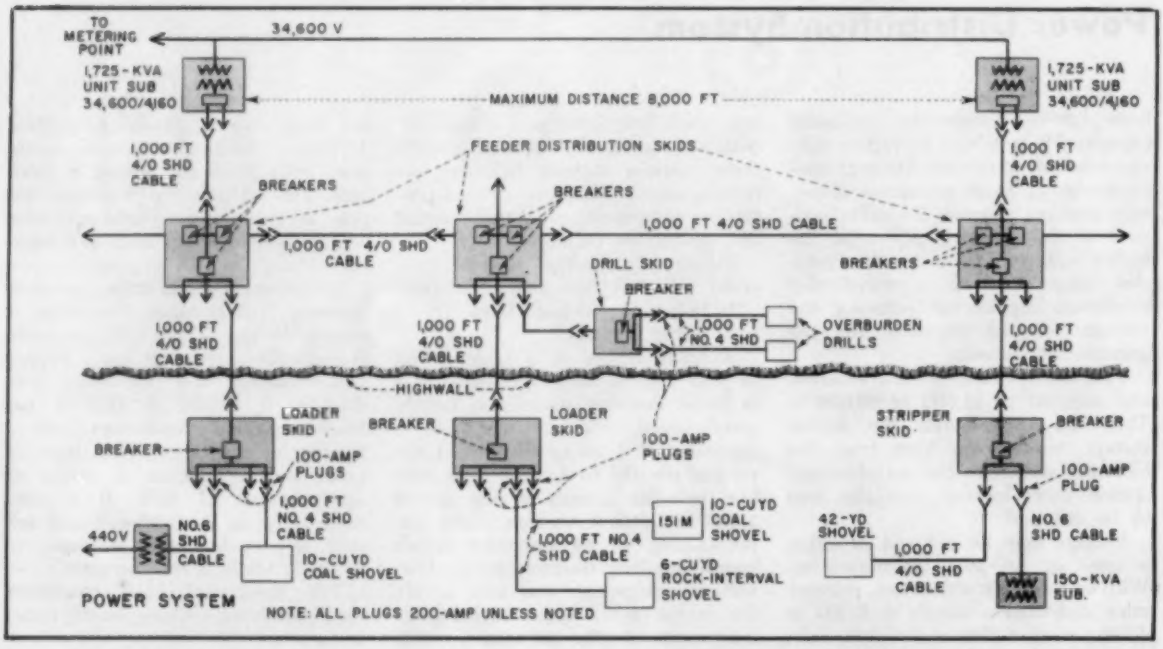
The theoretical ideal conditions for paralleling three-phase transformers are:

1. Same phase rotation
2. Same phase-angle shift
3. Same polarity
4. Identical turn ratios and voltage ratings
5. Equal per cent impedances
6. Equal ratios of resistance to reactance.

Since the substation units at this mine are identical, the last five items above are automatically taken care of. To parallel two or more substations, phase rotation must be the same. Phase rotation refers to the order in which the terminal voltages



ONE-LINE DIAGRAM of triple-breaker skid shows how ground-fault and continuity-check circuits are built in.



HOW power is distributed in loop system that has two easily moved skid-mounted substations plus portable auxiliary units.

reach their maximum values. In paralleling, those terminals whose voltage maximum occur simultaneously are in phase and are connected together by the circuit breaker. Each substation unit is equipped with necessary equipment that will not permit the breaker to be closed, paralleling two substations unless the voltages on both sides of the breaker are the same phase. Added safety features are incorporated within the substation design to indicate to the operator of the substation the unit voltage level and load at all times on both sides of the breaker.

Ground-Cable Systems—A fair number of strip mines use the "ground-cable" system instead of pole lines, or a combination of ground cables and pole lines. Otherwise, the basic plan is the same. A complete system consists of the main cable and the laterals, the cable being fabricated in sections of 1,000 to 1,500 ft as a rule with connectors for termination in switch-houses or for joining the main-cable lengths by junction boxes. Several types of cable may be employed but the most common is Type SHD. Construction includes copper shielding braid over each insulated conductor to equalize surface stresses and eliminate static discharge—the cause of corona cutting. The shielding must be at ground

potential at all times, and therefore must be properly grounded, which also eliminates the hazard of shock in handling the cable. Grounding conductors are placed in interstices. It is the safest and most widely used for high-voltage (up to 15,000) portable power applications.

Within limits, distance of transmission of 4,160 volts becomes critical, as a rule, only with the heavy loads encountered in the use of large shovels and draglines rated from 20 to 25 cu yd and up where connected horsepower per unit runs from approximately 2,000 to 5,000. Under such circumstances, the transmission distance for 4,160 volts normally should not exceed 5,000 to 6,000 ft. Above that, at high-voltage—33,000 for example—a pole line is cheaper to construct and also improves regulation and reduces power loss.

From a previous top of 46 to 50 cu yd, dipper capacity reached a new high of 60 cu yd in 1956 and the 75-yd shovel is now under construction. At the same time, a new high in connected horsepower, main AC motors, was established, resulting in a decision to break another barrier—operating voltage. Compared to the previous high of 4,160, the new shovel was designed to operate on 6,900 volts. Peak power demand is 6,840 kw.

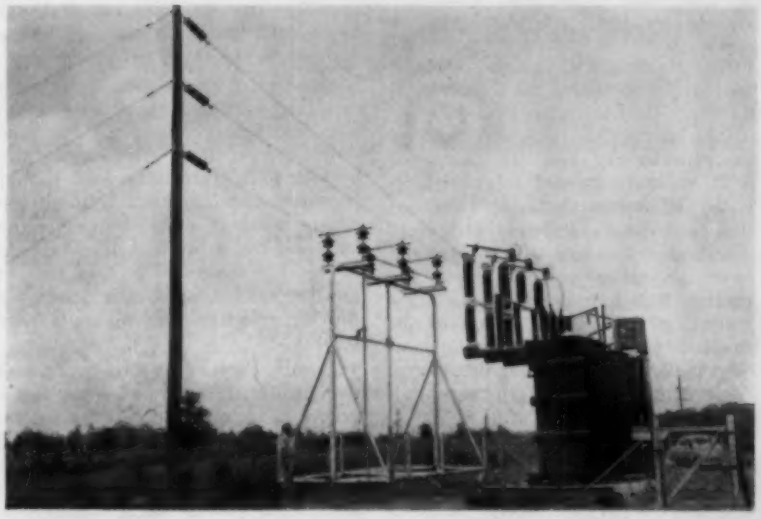
Power at the mine where the 60-yd shovel works is purchased at 66,000 v and stepped down to three-phase 6,900 v by a 500-kva transformer. The 6,900-v power is fed directly to the shovel cable after passing through a circuit breaker. An automatic reclosing type, the breaker will reclose after 55 sec. If opened again, it locks out. If it does not reopen, it resets for another cycle after 60 sec.

The 6,900-v cable is tapped at a splice for joining a 500-kva 6,900/4,160-v three-phase transformer. The 4,160-v circuit supplies power to auxiliary pit equipment and has its own ground circuit. Hence ground faults in the 4,160-v circuit will not trip the 6,900-v breakers.

The 6,900-v cable to the 60-yd shovel has one of the three ground wires insulated and a 110-v potential is maintained between the uninsulated ground wire and the insulated wires. On the shovel there is an annunciator circuit connecting the insulated wire and the equipment frame. Thus any broken frame to ground connection will warn the operator of the fault.

Protection—Primary items involved in the selection of a protective grounding system include:

TWO IDEAS to ease handling and prevent wear and tear of power cables are a suspension boom (above) made from scrap shovel and skid (below) for pulling cable.



GANG-OPERATED disconnects mounted on skids permit fast uncoupling and moving of skid-mounted substations as stripping moves ahead.

1. The maximum value of machine frame to ground voltage during a ground fault.

2. The magnitude of fault impedance that can be relayed.

3. Provisions for checking continufty of the ground-wire circuit.

4. Establishing a protective ground separate from the substation ground.

5. Proper choice and rating of components to maintain low frame-ground voltage in event of failure to trip on a ground fault.

6. Immediate isolation of a faulted feeder from the remainder of the system.

The frame-to-ground voltage that is developed under fault conditions is approximately the ground current times the impedance of the ground wire. This is the potential to which a man standing on the ground and touching the machine would be subjected to when a ground fault occurs.

In a system having a resistor limiting ground fault current of 25 amp where the ground-wire impedance in the cable is 2 ohms, the machine frame-to-ground voltage would be 50. In a system having a 50-amp ground current limit and a 2-ohm impedance in the ground wire, the voltage will be 100.

If there is more than one substation used and each has its own ground-current limiting resistor to keep each ground current to 25 amp, paralleling them will permit a total of 50 amp to flow in the ground wire in event of a ground fault. The potential drop in the ground wire then would be 100 v. If more than two similar substations, each with its own ground-current limiting resistor, are used the total ground current that would flow in the cable ground would be the sum of all substations.

The grounding resistor will establish the maximum ground current that can flow under solid fault conditions. The tripping current that would isolate a faulted feeder should be considerably less. The ratio of limit value to ground relay pick-up value determines the fault resistance that can exist and still obtain tripping. The higher this ratio the greater the fault resistance can be for relay pickup. It is improbable that a high-resistance will clear, therefore its immediate isolation is advantageous. The ability to relay a high-resistance fault is important in safety grounding systems.

For example, one recommended plan uses a 25-amp ground-current limiting resistor and a ground-detecting transformer and relay combination set to trip at 5 amp ground fault. On a 4,160-v system this resistor value from ground to each phase would be 96 ohms. In a 4,160-v system the line to neutral voltage is 2,400. Thus a total resistance—grounding resistor plus ground wire plus 2,400 divided by 5, or 480 ohms and still obtain 5 amp in the ground circuit. Subtracting the 96 ohms of the resistor from the 480 ohms would permit 384 ohms in the fault. Thus fault resistance between 380 ohms and 0 ohms could be relayed.

Successful functioning of the safety grounding circuit depends on the ground conductors from the machine frame back to the substation being intact. If the ground is broken or an open terminal connection develops, the protection is impaired.

There are various ways of checking ground-wire continuity. Sometimes a check is made at the start of the shift by imposing and artificial ground fault on the unit and noting tripping of the feeder breaker. The latest method is to provide continuous monitoring of the ground-wire circuit. Sometimes an alarm sounds in the equipment and warns the operator that the ground circuit is not intact. Other methods actually trip the supply breaker. In each of the continuous systems either a pilot wire is required in the cable or one of the grounding wires must be insulated from the other ground wires.

To minimize the rise in potential of the protective ground and the frames of mobile machines to which it is connected during the lightning arrester dicharge, or in case of flashover of any of the substation equipment, the substation protective ground resistor should be connected to a separate ground. This ground should have as low a resistance as possible—under 5 ohms—and should be located some distance from the main substation ground.

Since one of the main purposes of the grounding system is to isolate a faulty feeder as quickly as possible, ground fault tripping on the breaker unit nearest the load should be made instantaneous. If there are other breaker units between the load and the substation, these should be set for the same ground current as the unit nearest the load but provide selective tripping on a time basis.

Power Factor—To prevent power penalties resulting from power factor below that specified in the power contract, synchronous motors, 0.8 leading, are installed on the m-g sets on large excavating units. Without correction, power factor would usually average between 68 to 85%, but with the proper correction will be up to 90 to 95%, which will be above the penalty area.

Cable Testing and Fault-Finding—Insulation failures and shorts in high-voltage distribution or service cables in strip pits can cause major delays unless special facilities are provided for locating them. Without such special equipment, about the only method is to apply high voltage and current and blow the cable up at the point of fault.

Equipment for testing and fault location may be made or purchased. A testing outfit that may be made up from purchased components employs, among other items, a half-wave rectifier tube and filament and plate transformers to produce DC at up to 30,000 v and 40 milliamp, or sufficient to test up to 7,500 v. In operation (*Coal Age*, May, 1953, p 108) voltage is applied slowly to one conductor, with other conductors, shield or shields and ground wire or wires grounded. When the cable is fully charged, the current flow is the true leakage current, registered on a milliammeter. The voltage is held for a period and leakage current is determined at intervals to develop a polarization curve. The shape of the curve indicates the electrical condition of the cable and exposes potential insulation weaknesses.

For locating faults, the test equipment is modified by the addition of a spark gap and condenser. Location is achieved by picking up the discharges sent forth by the condenser and spark gap, which are audible at the trouble spot if there is water soaking or there is not a dead short. Where this is the situation, the observer has only to walk the cable. If the fault resistance is very low, dead ground or under water, a pick-up coil and earphones are employed and the fault point is marked by a change in the signal. Commercially developed units may be purchased to achieve the same results.

Drainage

Prevent inflow to the pit whenever possible.

Employ gravity as much as possible to drain pit accumulations.

Consider automatic controls for pumps to cut labor cost.

Use check valves in suction lines to eliminate the need for priming.

THE AIM IN DRAINAGE is to handle water at as low cost as possible. Good drainage procedures can pay off in lower material cost and less labor. Also men and equipment will

perform better if the working area is kept free of water.

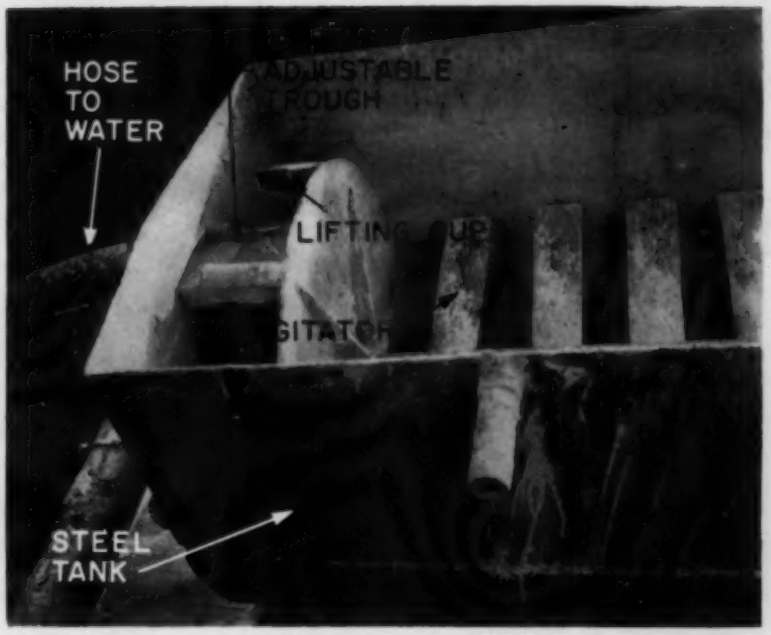
To keep drainage costs to a minimum, water should be kept from entering the pit and off the haulage roads. Several ways of doing this include: (1) diverting streams to new channels to prevent seepage into the work area; (2) ditching above the highwall to divert surface runoff away from the pit; and (3) building flumes to span the pit.

When water does enter the pit, as a result of rainfall or seepage, gravity should be used as much as possible to remove it. By exercising care in spoiling, leaving windows in the spoil areas or putting in crib culverts or drain pipes at intervals, water can be handled economically. If grades favor it, one end of the pit may be kept open to release all the water. In some cases it will pay to blast a ditch in the pit floor to permit water to flow by gravity to a drainway in the spoil.

Portable pumps, either mounted on skids or wheels, are the leaders where pumping is required. These are used in a variety of sizes and capacities, depending on the job to be done and are powered either by electric or diesel motors. Many of the units are controlled by float switches that stop or start them automatically, thereby cutting labor costs.

The hose is popular for temporary water lines but is frequently supplemented by a variety of new materials, including flexible plastic, special rubber and aluminum pipe. Resistance to corrosion, rot and abrasion have made plastic pipe more popular, while ease of handling makes aluminum desirable. Threadless couplings, in addition to the advantage of fast joining and installation of pipelines, also permit individual joints of pipe to be rotated 180 deg if a small leak occurs in the bottom as a result of abrasion. Thus pipe life can be greatly increased. Check valves should be included in all suction lines to eliminate the need for priming pumps. However, this may not be desirable in weather when there is danger of the lines freezing. If corrosion and abrasion are problems, impellers and pump interiors can be coated with rubber-base material to increase their life.

To prevent acid water from entering the water sheds of surrounding streams, one company developed an automatic device that provides low-cost water neutralizing (*Coal Age*, February, 1957, p 101). Six sumps, each with its own pump, are strategically located on the property. Each pump has a separate automatic treating tank. Water is treated automatically with lime solution and delivered to settling areas before it is permitted to enter the water basins.



LOW-COST water neutralizing is provided with automatic feeding of power-mixed lime solution to acid water as it enters the suction line. Details of mixing and feeding tank are shown below.

A steel mixing tank at each pump is partially filled with water and 400 lb of hydrated lime is added. As the lime enters the tank it is thoroughly mixed with the water by a power-driven agitator.

Lifting cups attached to one end of the agitator pick up the solution at one end of the tank and discharge it into an adjustable trough at the top of the tank. The trough leads to a 2-in hose that carries the lime solution to a point adjacent to the pump suction line. As the solution flows into the acid water it is pulled into the suction line of the pump. In the short journey to the pump and in the pump itself the solution is mixed thoroughly with the acid water.

A tank of solution lasts each pump for 2½ to 4 hr, depending on the acidity of the water. The quantity of solution delivered to the sump is controlled by moving the adjustable trough backward or forward.

Fixed Discharge Stacker . . .

RAW-COAL CAPACITY of 5,000 tons is provided in this setup employing fixed-discharge stacker with spiral lowering.

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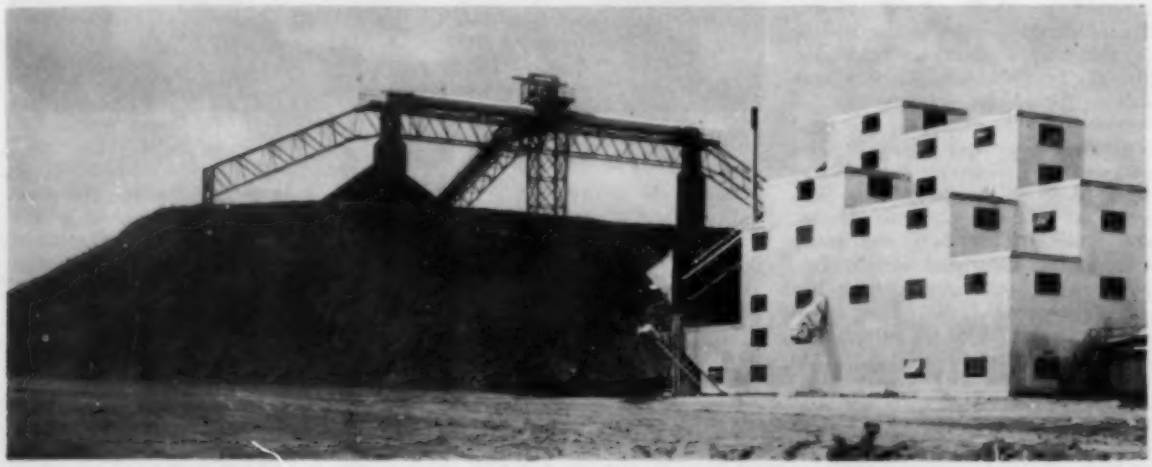


Reversible Stacker Belt . . .

TWO CONICAL PILES, each for coal from one seam, are formed by reversible belt with ladder lowering chutes.

Bin Storage . . .

FOUR 500-TON COMPARTMENTS in this raw-coal storage setup also provide opportunity for blending feed to cleaners.

Trend Markers—Preparation

Storage facilities for both raw and clean coal being installed at an increasing number of mines.

Facilities for complete recovery of useable material—coal, near-gravity material and fines—being included in an increasing number of plants, with emphasis on fine-coal recovery and beneficiation where the economics favor.

Conformity with antipollution regulations in addition to a desire to increase recovery resulting in major growth in the installation of facilities for clarifying water.

Desliming with various types of equipment being increasingly practiced to improve the efficiency of fine-coal washing and especially dewatering in filters or other mechanical equipment.

Ultrafine screening being developed to assist in sizing and dewatering of the fines and ultrafines.

THE ULTIMATE CONSUMER is the biggest single factor in the business of coal preparation today, as he always has been. But satisfying a customer now is a radically different thing from satisfying him in the earlier days of coal preparation. The premium is on economy and convenience in use as a result of rising costs not only for coal but for equipment in which to burn it. To provide the maximum in economy and convenience, coal producers have consistently increased their investments in preparation facilities to increase consumer satisfaction in these four ways:

1. Proper size for the particular application.

2. Maximum Btu content per dollar spent by the consumer through elimination of impurities and moisture. Good sizing also plays a part here, too, by making possible more complete combustion and thus more liberation of heat at the point where it can be effective.

3. A high degree of uniformity in all characteristics—size, heat content, ash and so on—meaning a product on which the consumer can depend day after day and year after year. Uniformity can be even more important than, for example, maximum impurity removal.

4. Maximum convenience in use. For example, should the coal be treated to eliminate dust in handling? Should the coal, if washed, be dried or treated with oil or chemicals to eliminate unloading and handling difficulties in freezing weather?

Satisfying the Market

First, it is assumed that the market today and in the future will require both sizing and cleaning, plus drying and other convenience treatment. This assumption is made in spite of the fact that there is now considerable discussion—and some examples—of the so-called raw-coal principle. In essence, this principle is that shipping a product with no or only rough cleaning and crushing—and at a price—results in a better value for the user and more profit for the producer. Manifestly, the principle—if it ever found widespread acceptance—would find such acceptance primarily in the large-volume power-plant field, though it is difficult to see, except for certain spot situations, how the advantages of low impurity content, accurate sizing and uniformity could be offset.

In setting up a preparation plant or system for attainment of desired sizing cleaning, uniformity and convenience standards, the first job is to ascertain to the maximum degree possible what the market will require in:

1. Size of product. For example, the trend still is toward the smaller

Case-Finder—Preparation

Fluidized-Bed Drying—Flowsheet and process description of system for 3/16x0 table coal. Plant also set up to wash 3x0, reclean 3/16x0 on tables and dewater in centrifuges prior to fluidized-bed drying, and heat dry 1½x3/16 in conventional units. *Coal Age*, July, 1956, p 76.

Dry-Cleaning 3/4x0—Vacuum jig handles 25 to 30 tph, reducing ash from 25% to 12%. *Coal Age*, August, 1956, p 72.

Central Plant—Special steels installed to cut maintenance in plant with sand-flotation and table cleaning, plus radial desilting screen in coal circuit and bowl desilters in table circuit. Centrifuges and thermal equipment remove moisture. *Coal Age*, September, 1956, p 78.

Barge Loading, 5,000-Ton Stockpiles—Two 5,000-ton stockpiles permit separate handling and blending of coal from two seams. After washing, drying and sizing coal goes into earthen storage pocket feeding a barge-loading installation using a tripper belt. *Coal Age*, October, 1956, p 80.

Metallurgical Processing—New plant includes four 500-ton raw-coal storage bins, blending feeders, jig and table equipment, centrifugal dryers for 1/4x28, disk filters for 28x0, and thermal equipment for final dewatering of centrifuge and filter products. *Coal Age*, October, 1956, p 79.

Simplified Flowsheet—One modern heavy-medium unit replaces several older cleaners, saving in labor, maintenance and capital cost. Ground storage is provided for both raw and clean coal. *Coal Age*, October, 1956, p 90.

Barge Loading—Six types of barge-loading plants to meet various loading and river conditions. *Coal Age*, December, 1956, p 58.

Oil-Treating Guide—What to use oil for, oil selection, and treating methods. *Coal Age*, January, 1957, p 78.

Coal-Weather Treatment—How coal and cars are sprayed with oil to reduce freezing; quantities and costs. *Coal Age*, February, 1957, p 75.

Dense-Medium Washing—Primary treatment and retreatment in main and secondary baths to achieve 6x3½ with less than 7.35% ash. Dry plant with jig for middlings treatment handles minus 3/8. *Coal Age*, February, 1957, p 76.

Gravity-Flow Coal Cleaning—All normal circuits in plant using hydraulic-powered heavy-medium unit are gravity flow. Rough cleaner placed in separate structure to reduce vibration in main plant. Stainless steel and aluminum cut maintenance. *Coal Age*, March, 1957, p 61.

Independent Operation Through Stockpiles—New washing plant includes 15,000-ton raw-coal and 36,000-ton clean-coal storage facilities to permit mine, preparation plant and barge-loading plant to work independently when necessary. *Coal Age*, June, 1957, p 74.

sizes, and is being accelerated by the growing use of coal by the electric utilities.

2. Ash, Sulphur, heat and moisture content.

3. Dustproofing, freezeproofing and other convenience factors.

Next, the coal itself must be studied. It may, in its natural state, provide some of the desirable qualities—or in some exceptional cases, all of them. Where it doesn't provide them, can it be treated so that it does? The latter question usually is the critical one. It may be possible to process a certain coal to meet very rigid requirements for ash, but in the processing it may be necessary to reject an excessive percentage of the raw feed. Therefore, when all the pros and cons are weighed, a greater realization may be secured by a higher ash and a higher recovery with a high degree of uniformity in the final product.

Achieving Low Cost

Control of plant cost is to some extent in the hands of the operator and to some extent not. If the market requires dried coal, the operator perforce must install drying equipment or suffer a handicap in his selling operation. Increases in plant cost may be mandatory for other reasons. One, for example, is prevention of stream and air pollution, which may be necessary from the public-relations standpoint even if not required by law.

Expenditures which may be optional and thereby are within the control of the operator might include, for example, recovery and dewatering equipment for sludge, or for the finer fraction of a sludge or slurry product, If, as an example, it was possible to recover 2 tons of minus 28M with an acceptable quality, but such recovery required evaporating 5 tons of water at $2 per ton, it probably would be better to spend the money, other things being equal, on mining fresh coal. However, if it is necessary to put in equipment to recover and dry the coal to prevent stream pollution, then an additional expenditure for cleaning equipment—flotation, for example—might well be worth while from the standpoint of value received for the extra expenditure.

Raw-Coal Storage

PURPOSES:

1. Preventing interruptions in mine operation from shutting down the preparation plant and vice versa.

2. Providing some degree of blending of the raw feed to the plant.

3. Providing a means of evening out the flow of coal to the preparation facilities, thus permitting washing equipment, for example, to do a better job.

Capacity

Even where raw-coal storage facilities are underground, the prevailing practice is to provide at least ½ hr of the rated capacity of the mine or plant, with 15 min as about the minimum for anything more than a hopper to hold a car or two. From 15 min to ½ hr also seems to be the rule at most strip-mining operations receiving coal from trucks.

A trend toward even larger storage capacity seems in evidence, however. Examples include the following:

Deep mine, outside bin mounted on structural members under a dump bridge and receiving coal from drop-bottom cars, 2,500 tons of capacity for a plant rating of 700 tph.

Deep mine, 5-compartment silo mounted on hill about plant, 2,200 tons for a plant capacity of 600 tph.

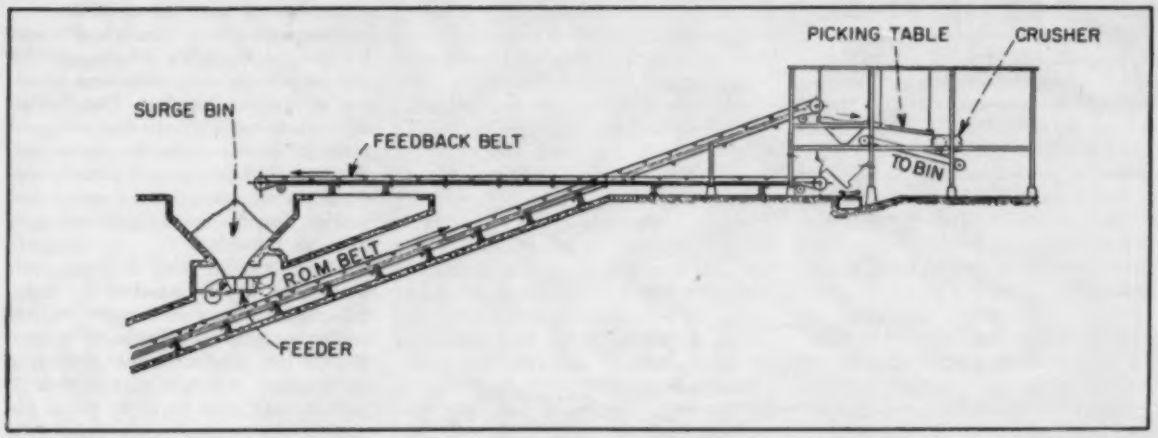
Deep mine, four 500-ton raw-coal storage bins for a plant capacity of 350 tph (*Coal Age*, October, 1956, p 78).

Central plant, four 600-ton storage bins for plant capacity of 800 tph (*Coal Age*, September, 1956, p 78).

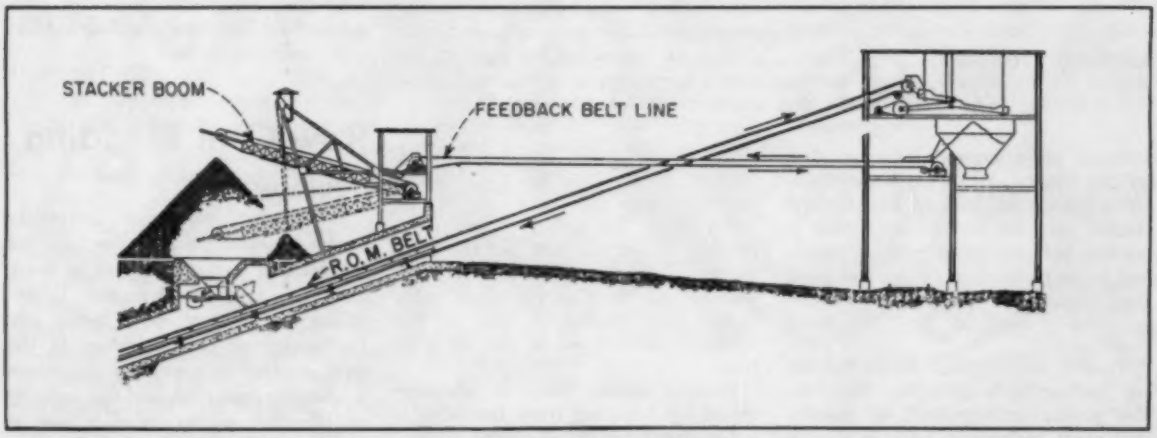
Where ground storage is provided, capacities up to 2 or 3 days are provided in some instances, as follows:

Deep mine, bin over slope belt with feedback belt from preparation plant, 10,000 tons, including ground area around bin.

Deep mine, ground storage with feedback belt over glory hole back to slope belt, approximately 1 day.



RETURN VIA SLOPE BELT is a feature of this ground-storage plan using a feedback conveyor to place the coal in a hopper. Storage with this system is limited by the size of the hopper or surge bin.



INCREASED CAPACITY in ground storage over slope belt is provided by stacker boom. Raising end of feedback belt and using a bulldozer or dragline for reclaiming is another method of increasing capacity.

Strip mine, ground storage fed by stacker belt and spiral lowering chute; capacity, 5,000 tons; reclamation by feeder and belt (*Coal Age*, August, 1954, p 64).

Strip mine, two 5,000-ton stockpiles, one for each of two seams mined; piles fed by reversible stacker belt and lowering ladders; coal reclaimed by feeders under piles delivering to blending belt (*Coal Age*, October 1956 p. 60).

Underground Storage

Capacity of one hopper feeding a slope belt at a plant rated at 500 tph is 260 tons. The hopper is 16 ft wide and 66 ft long. Maximum depths is 18½ ft. Designed to receive coal from a belt system this hopper is fitted with a shuttle-type distributing conveyor with hinged boom end. The boom sections permits laying coal into the hopper with minimum degradation. The shuttle principle also makes possible maximum use of bin capacity.

The dumping characteristics of dropbottom cars also permit maximum use of bin capacity and thus can cut down size and depth; for example 96.7 tons in a bin 40x12 ft by 10 ft deep.

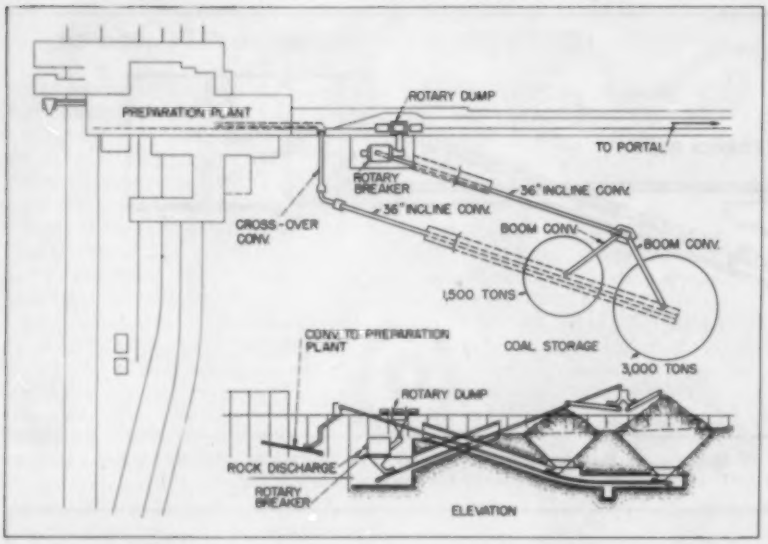
Size of underground hoppers occasionally reaches as much as 2,000 tons. Usually hoppers of this size are employed where there are two seams close enough together so that the hopper can be excavated in the interval to receive coal from dropbottom cars. A recent 2,000-ton hopper for example was placed in an interval of 105 ft between two seams and holds all the second-shift production from the main seam feeding to a reclaiming conveyor which in turn discharges to the main slope conveyor (*Coal Age*, June, 1955, p 60).

Surface Storage

Although some form of bin or hopper still is the most popular form of surface storage of raw coal there is as previously noted a trend toward open or ground storage.

Two examples of surface storage designed to permit return of the coal via the main slope belt are shown in the accompanying illustrations. In one, capacity is 200 tons in the form of a glory hole. However, if the discharge end of the recirculation belt was elevated and a bulldozer or dragline was added, as in certain other installations, capacity could be raised to 10,000 tons or more. In the second design, additional capacity is attained by using a hinged stacker belt. Here, too, capacity may be increased by lengthening the stacker belt and adding a bulldozer, dragline or other reclaiming unit.

Even where slopes are not involved, the trend today with large storage setups is to use belts for both stacking and reclaiming. A single pile may be laid down in the form of a cone by discharge from a stacker belt with a fixed end. Or the stacker belt may be arranged with one end on a truck



GROUND STORAGE here involves rough cleaning, distribution to two funnel-shaped pits by boom conveyor, and reclamation by feeders to subway conveyor. Storage and reclamation is either automatic or remotely controlled.

running on a curved track so that an arc-shaped pile can be formed. Or a strung-out pile of any desired length can be formed by using a stacker belt equipped with a traveling tripper. Straight or conical piles lend themselves better to reclamation by subway conveyor, now the usual practice.

Double conical piles may be formed by feeding to a reversible belt. By the proper arrangement of feeders and short reclaiming belts, coal may feed out of either or both piles for preparation alone or as a blend. Another method of forming double conical piles is by the use of boom conveyors preceded by a flygate as shown in the accompanying plan. In this instance, the bottoms of the cones are in pits formed by excavating to make it possible to feed the coal out completely without supplementary equipment. If the piles are placed flat on the surface of the ground it usually is necessary to employ a bulldozer, scraper or other unit to move the coal to the feeder after the natural center draw is completed. Boom-type stacking conveyors also provide one answer to the problem of reducing degradation in piling. With fixed-discharge conveyors, lowering spirals or ladders normally are required.

The plan illustrated also exemplifies a common practice in storing raw coal, i.e: preliminary reduction in size and rough cleaning in a rotary breaker. The flygate in this particular installation is remotely controlled, electrodes are installed on the ends of the boom conveyors to raise them automatically when the coal level reaches them. One of the funnel-shaped storage pits has a capacity of 3,000 tons; the other 1,500 tons. Feeders under the pits put the coal on the reclaiming conveyor. A more uniform raw feed to the plant, with better final quality, is one of the expected advantages of the installation.

Ground storage may be accomplished by dumping from trucks in a flat pile with bulldozer spreading. Reclamation may be by standard shovel and trucks or by tractor-mounted shovels. And where trucks are employed, a variation applicable to hilly country is to excavate a bench in the hill, with trucks dumping over the back wall and conventional equipment picking up the coal as desired from the bench.

Storage of large quantities of coal in piles or elsewhere requires checking against the possibility of spontaneous combustion.

The conventional square or rectangular bin—steel, concrete or timber—still is the most-used method of providing raw-coal storage where open or ground storage is not employed. Two old hopper cars, one on top of the other, have been used in some instances. However, the round, or silo-type, unit is being increasingly installed. The silo may be built by conventional concrete-pouring methods or may be constructed of regular plate or prefabricated steel sections, or of precast concrete staves bound with steel hoops. A silo 24 ft in diameter and 55 ft high will hold up to 600 tons of coal.

Compartmented or multisilo bins are employed at a number of mines for greater flexibility in storage and also to provide some degree of blending of the raw product. Distribution to a side-by-side or four-cornered multiple unit may be by chutes and flygates. Indicators and remote-controls permit operation of gates and proper distribution without having a man at the bin.

Distribution to long multicompartment bins may be handled by a distribution belt with tripper. Other methods include a wheel-mounted shuttle belt similar to that employed in loading railroad cars which is moved back and forth to place the coal in the proper compartments. Or a scraper conveyor with fixed openings or movable gates may be used.

In deep bins, degradation may be reduced by installing spiral or ladder-type lowering units.

Raw-Coal Blending

PURPOSES:

1. Assuring maximum uniformity in the characteristics of the coal fed to cleaning units and thus in turn, assuring a better final product by enabling the units to do a better job. Uniformity of characteristics in the final product is especially important in metallurgical coal, and the majority of blending plants to date are at metallurgical mines.

2. Providing storage capacity and evening out the rate of flow to cleaning units, thus helping to promote uniformity and quality in the final product in another way.

Since the usual goal in blending raw coal is splitting it up into small increments and then recombining it, also in small increments, the normal blending plant consists of a multicompartment bin with a relatively large capacity—usually 1,000 to 2,000 tons or more. The more the compartments, within reasonable limits, the more the opportunity for splitting and recombining. Also, to facilitate putting small portions of coal into each compartment, the usual practice is to employ a belt with a traveling tripper, though other methods of distributing the coal may be employed. To complete the recombining—and blending—coal normally is withdrawn from all compartments at the same time. Variable-speed feeders are common for this purpose, and permit changes in individual feeding rates to compensate for changes in needs.

Normally, the coal is placed in the blending plant after preliminary cleaning and crushing.

A less-common type of blending is getting the desired mixture of coal from, say, two different seams. This requires a bin or set of bins for each, which may be filled in any of the usual ways, including dumping directly from mine cars or from railroad cars at a central or "milling-in-transit" plant. Blending of two coals also may be accomplished by feeding as desired from side-by-side ground-storage piles to a plant feed conveyor (see previous section on "Raw-Coal Storage").

Preliminary Breaking

PURPOSES:

1. To reduce all oversize material in the raw feed to a certain top size, say 6 in, usually done where the market for lump is considered too small to warrant preparing this size or where the coal is destined for, say, metallurgical use.

2. To reduce extra-large lumps without especially attempting to get everything to a certain top size. Convenience and smoothing out the flow of coal through the plant are the major objectives in such breaking. Freeing bone or partings from coal to facilitate picking or cleaning is another objective in some instances.

Preliminary breaking and certain rough cleaning usually go hand in hand, although, for example, if coal is being transferred from a hopper to a crusher preceding a slope belt underground, no attempt is made as a rule to remove rock or impurities before the breaking process. On the surface, however, it is generally accepted that where substantial quantities of rock are encountered it is best to remove at least part of it before sending the product to the crusher. Consequently, particularly where all the coal is to be washed, it is common practice to employ a picking table or—as is increasingly the case—a scalping screen and picking table ahead of the crusher.

Preliminary breaking is almost entirely the province of the roll-type machine although some pick breakers are employed to get closer to the desired objective of reduction with a minimum production of fine sizes. Roll diameter, tooth design, tooth positioning and speed are major factors, along with keeping teeth in good condition at all times. Double-roll crushers are considered to give a higher proportion of coarse material because abrasion against the plate is eliminated. Feeding practice also influences results in this direction. Consequently, usual practice is to scalp out fines and send only large material to the crusher.

In anthracite particularly, stage crushing has been the practice for many years because of the nature of the raw product and also the size list produced. In anthracite it sometimes happens that the rock exceeds the coal in the raw feed and therefore picking sometimes is set up to remove coal from the rock rather than vice versa. Whatever the system, however, after scalping out the fines, the coarse coal goes through the first rolls, after which the process of scalping and additional breaking of the large material may be repeated a second and even a third time.

To avoid a multiplicity of units, crushers are offered with a second stage of reduction built into them.

Crushers normally are built to handle iron, particularly if it is not too large. However, the better practice is to keep it out not only of crushers but of the entire plant circuit. If possible, therefore, magnetic removal equipment should be installed ahead of raw-coal crushers.

Rough Cleaning

PURPOSE: Quick removal of coarse rock and other impurities to reduce the burden on subsequent preparation units and also to permit higher efficiency in the removal process itself.

The major rough-cleaning methods are as follows:

1. Use of a picking table receiving all the mine-run product.

2. Use of a scalping screen followed by a picking table. This is a perferred system, since it removes the fines and thus facilitates picking, which may be either rough with the idea that final impurity removal will take place in mechanical cleaners, or may be final where the coarse coal is to be loaded without any further treatment.

3. Use of a rotary screen-type breaker, which accomplishes both a reduction to a certain top size, depending upon the size, of perforation, and rejects the hard rock—or at least that portion of it larger than the perforations. Normally, where rotary breakers are employed final cleaning is done in mechanical equipment.

4. Use of roughing cleaners to throw out the major part of the heavy material and prepare the feed for the final units. Fines may be bypassed around the roughing unit, while large lump usually is processed by hand picking. Preliminary breaking may also precede roughing with a mechanical cleaner. A further refinement is hand picking to remove coarse, heavy material, followed by breaking and roughing.

Rough cleaning by hand frequently precedes breaking, as noted in the previous section, and has the advantage, among others, of reducing the load on the breaking unit and reducing the output of fine sizes, in the breaking operation by getting the hard, heavy rock out of the way.

Separate headhouses or roughing plants are being increasingly employed for preliminary breaking, rough cleaning, mine-rock disposal and raw-coal screening.

Raw-Coal Sizing

PURPOSE: Separation of the feed into the necessary fractions to permit picking, cleaning and other operations on the various fractions. In plants preparing by hand picking and cleaning, the raw-coal screen may also make the final sizes to be loaded.

The shaker screen, inclined at approximately 15 deg and with a crank or accentric drive providing a stroke of around 6 in and a speed of 100 to 120 strokes per minute, is the common type of raw-coal sizing device. It is receiving increased competition, however, from vibrating screens, usually of the mechanical type.

A major difference between the two types of screens lies in the fact that the shaking unit also can be employed to convey and distribute the products, including provision for hand picking, as in plants preparing by hand picking and screening,where one shaking unit, with decks and extension as necessary, can size the coal, provide facilities for picking, and distribute a number of sizes to their respective loading booms and chutes. If the unit is inclined at the usual angle, lengthening it out requires more headroom. This, among other reasons, resulted in the development of the level shaker with differential-motion drive to move the coal along the unit.

A second difference between the

two types of screens is the fact that the vibrating type, though it cannot do conveying, provides higher capacity in a given space in many instances. Degradation with either depends upon type of coal, type of screen and method of operation.

The flexible-arm or Parrish-type screen, usually operating at 150 to 185 rpm, 5- or 6-in stroke, 2- to 5-deg slope, is another form of shaker. However, its major use is more for final sizing and dewatering, especially in the anthracite field, where it is widely used for this purpose. Laminated-plastic hangers are now used on such screens instead of boards (*Coal Age*, September, 1955, p 67). Advantages include longer life, no change in length and better screen action.

With the growing trend toward mechanical cleaning, the raw-coal sizing screen is more and more being called upon for a rather simple separation of the raw feed into two or three fractions. Where this is the situation, the shaker can be a rather short machine. This situation has favored the rise of the vibrator in raw-coal screening also. Even where only a certain fraction of the coal is mechanically cleaned—screenings, for example—or only a certain size or sizes are treated—nut and pea, for example—the simple two- or three-product shaker may be employed with further raw-coal sizing allocated to vibrating screens.

Screening Factors

In addition to inclination, speed and length of stroke (or amplitude with vibrators), some of the factors affecting screening results are:

1. Depth of bed. Since screening can be accomplished only when the smaller sizes work their way down to the plate, depth of bed, in conjunction with size of opening and square footage of screening surface, is a major factor. With large openings, depth of bed may be greater. With smaller openings, bed depth must be reduced or the area of screen surface must be increased. Time on the screen also is a factor, though the opportunities for increasing it are somewhat limited and where it is increased degradation and breakage tend to increase with it.

2. Degradation. As previously noted, time is a factor in degradation. Narrow shakers also tend to increase degradation, and there is a major increase when more screen surface is provided than is necessary to accomplish the desired separation.

3. Wear. Heavy loads, coarse material and the possible presence of considerable rock are factors in wear on raw-coal screens. Among the answers for vibrating equipment is heavy alloy wire or alloy plate. On shakers, types of plate used to reduce wear include cast manganese.

Hand Picking

PURPOSES:

1. Impurity removal.

2. Improvement of appearance.

3. Production of a separate fuel grade.

From the standpoint of impurity removal, hand picking normally is effective only on coal 3 in or larger in size. Hand picking may also be employed to improve appearance by removing off-standard material. In addition coal cleaned mechanically or otherwise may be picked before loading to remove wood chips, stained pieces and the like. Here, the operator must balance any gain in realization resulting from improved appearance against the cost of such picking, which is high.

Where bony by itself or in combination with good coal is fairly high in percentage, some operators use picking as a means of removing this material, which then is crushed and sold as a power-plant fuel.

Under reasonably good conditions, and where the impurity content is high, one picker can remove as high as 6 tph. Under average or poor conditions with a lower impurity content, production may drop to 1 to 2 tph.

Picking Equipment

Picking facilities include belt and apron conveyors, shaking tables and, occasionally, chain conveyors, the latter normally being employed only under special conditions and where the impurity problem is a minor one. All conveyor-type units lend themselves to combining the table with the loading boom.

The flat-topped apron conveyor and the shaking table best meet the major goal of removal of impurities without lifting or other handling beyond sliding the material removed to the discharge point. Other types of conveyors normally require skirtboards over the rollers or along the edges and thus necessitate lifting each piece to remove it.

The flat table may be a part of the shaking screen or may be separate. When separate, the table normally is sloped at about 5 deg and is operated at 150 to 160 rpm, 4- to 5-in stroke, crank or eccentric drive. Platform tables used in anthracite have a pitch of ½ to ¾ in in 12, with a 2-in stroke, 370 to 400 strokes per minute. The shaking table also lends itself readily to degradation removal by the installation of a screen section at the discharge end.

Some shaking tables have been equipped with partitions or deflection plates to further ease the load on the pickers by making it possible for them to do no more than push impurities out of the main stream to the center or pull them to the side, where the motion of the table carries the impurities to the discharge opening. Refuse chutes should be equipped with bars to prevent passage of pieces large enough to block the refuse conveyor.

Washing

PURPOSE: Efficient removal of impurities in both coarse and fine sizes, and attainment of maximum product uniformity with a minimum of cost.

Washing is a form of mechanical impurity-removal, or cleaning. Mechanical cleaning is growing because it has these definite advantages:

1. Mechanical cleaning is the only form of cleaning providing effective results on the finer sizes of coal.

2. A mechanical cleaner, properly adjusted and within the limits of its characteristics, provides the maximum in product uniformity—a major factor in market acceptance of the product.

3. Mechanical cleaning cuts labor costs per ton to the minimum and thus, compared to hand picking—at least in certain sizes—can sometimes reduce over-all preparation cost for a real cleaning job substantially.

What actually happens in the separation of coal and impurities is a complex and to some extent unknown physical process. Particle size and shape are involved, as well as the resistance of the medium used to movement of particles through it, and the fact that coal is cleaned as a mass of particles, with consequent interference between free movement of particles within the cleaning medium. In the main, however, separation is accomplished as a result of the difference in specific gravities of the coal and impurities in combination with the buoyant effect of the separating medium. In other words, where buoyance or its equivalent is present, the heavier particle will sink and the lighter will float, or the heavier will sink faster than the lighter particle.

Heavy Media—True or artificial so-

lutions, however, are increasing in use as separating media. The processes employing them are known by such terms as heavy media, dense media, heavy density, and so on. An example of the true solution used for some years is calcium chloride, normally accompanied by a slight upward current. For the most part, the effect of solutions is obtained by suspending sand or magnetite in water. Mediums derived from the natural refuse also have been used, and a new entry of this type is rock picked out of the coal and reduced to 4x325M in an impact pulverizer. Approximately two-thirds of the pulverized medium is minus 28M.

Since the ideal condition for separation of coal and heavier refuse is a still bath of the proper gravity, and since the true or artificial solutions come closer to this condition, the sharpness of separation is increased—an added advantage where the separation problem is difficult or where there is a need for a very-sharp separation under any feed conditions.

Other factors which may favor the use of a heavy medium include more-than-normal irregularity in quality and quantity of feed; a need for changing gravity from time to time; and operation at less than 1.45, where baths without upward currents theoretically offer the best conditions for a sharp separation, though capacity per square foot of area may be reduced.

Gaging Separation Difficulty—A good indication of the difficulty of separation is the amount of material in the raw feed that lies close to the gravity of separation. In other words, the greater the percentage of near-gravity material, the more difficult, as a rule, the separation. A good indication of the efficiency of a cleaning operation is the quantity of misplaced material—coal in the reject and reject in the coal. To apply this measure, however, the inherent ability of the cleaner itself to separate coal and refuse must be known, since cleaners vary in their ability to achieve a given separation. Evaluation of this ability is a somewhat complex process, but methods of achieving it include those in "Evaluating Preparation Results," *Coal Age*, April, 1950, p 80.

In the main, however, if the washer is properly selected, is kept in adjustment, and is properly operated (see suggestions later in this section) it will provide the requisite separating efficiency. Basic in selection is detailed knowledge of the characteristics of the constituents of the feed. First of all the sample must be representative of what the washer will be called upon to handle. Then screening, sink-and-float testing, and construction of washability curves will show what can be accomplished under what might be called ideal conditions. Where it is evident that the problem may be difficult and the maximum in efficiency is desired, it may pay to wash sizeable tonnages in pilot equipment or actual going plants to check test results. The results of washing a new coal may also be predicted by mathematical or statistical methods, such as that described in "How to Predict Results of Washing a New Coal," *Coal Age*, June, 1952, p 98.

Washing Practice

Factors in the application and operation of washing equipment include the following:

Size Spread in Feed—Certain types of washers require a rather small range in the size of the feed. Examples include the mechanical jig, classifier-type units, and certain washers using heavy media. The emphasis in design in recent years, however, has been toward equipment that will handle a rather large range of sizes—for example, the air-pulsated jig and the usual heavy-media equipment. The latter, incidentally, is now offered for handling a top size of feed ranging to 12 to 14 in.

Even where the washer is designed to take, say, all coal from 6 in down to zero, and can frequently do a good job on all the fractions in such a feed, some compromise must be made. In other words, somewhere along the line, the separation efficiency is less sharp—perhaps at the fine-coal end and perhaps at the coarse, depending upon washer design and adjustment. Consequently, if tonnage is fairly high and a sharper separation is desired throughout, the practice is to install separate units for the coarse and fine fractions—for example, one for 6x1 or 4x1, and a second for 1x0. Where the equipment requires a closely sized feed, the only out is to install separate units for each fraction it is desired to clean.

By-Passing Fines—Fine coal, say ¼ in or less, may be by-passed around washing equipment for several reasons: (1) to keep it out of water and thus avoid the ensuing drying and handling complications, (2) to permit more efficient operation of washing equipment installed to handle a rather wide size range, and (3) because of the problems involved in mixing of fines with medium, such as, sand and magnetite. The fines may be subjected to further treatment in other units or other types of equipment or, if both their quantity and ash content are not too great, may be mixed back into the washed coal.

Uniform Feed—A uniform feed, both in quantity per hour and in impurity content, adds measurably to the efficiency a washing unit can reach. The best method of attaining uniformity in quantity is the installation of some form of surge hopper or bin, plus a mechanical feeder, ahead of the washing unit. Attaining uniformity of impurity content is normally achieved by some form of blending equipment, as discussed previously in this Preparation Guidebook. Overloading should be guarded against particularly. While many washing units have a fair margin of excess capacity, overloading to any considerable extent is almost inevitably followed by a sharp decline in cleaning efficiency and in uniformity of product.

Feed Conditioning—Prewetting either in the feed chute or on special prewetting screens facilitates separation when the material reaches the washer, and consequently is finding increased use. Conditioning also is mechanical in nature. The feed, for example, should be uniform across the width of the washing area. Also, under certain conditions, particularly if prewetting is not employed, provision should be made for getting the feed quickly into the bath and to prevent clotting or travel enmasse, increasing the difficulty of separation.

Media Conditioning—Reclamation and treatment of the media used in heavy-media systems is necessary for at least two reasons: recovery of an expensive material that otherwise would be lost, and preservation of the proper gravity of the bath in the cleaning unit. Media include magnetite, sand, calcium chloride and, in a few new installations, natural or pulverized refuse.

With magnetite, the simplest system consists of a magnetic separator to reclaim the material, previously magnetized to permit this to be done, from the water from the rinse and drain screens. This recovered material then is demagnetized and sent on to a thickener or densifier, from which it is returned to the separator bath.

Variations include use of thickener with overflow back to the rinse and drain screens for part of the water, and underflow to a magnetic separator discharging reclaimed medium to a densifier. Tailings go to a second magnetic separator, also receiving

part of the rinse and drain water, with reclaimed magnetite to the densifier and tailings to waste.

Each of several heavy-medium separators in another plant is provided with two magnetic separators which return a concentrate of 2.2 sp gr and about 95% magnetic content directly to the medium circuit without further treatment. Tailings from all separators flow to a desliming sump. The underflow from the sump goes to two 12-in cyclones. Cyclone overflow is used as rinse water, while the underflow is reprocessed.

Automatic control of bath density is provided for in equipment employed with certain new heavy-media cleaning units. At one installation (*Coal Age*, October, 1955, p 63), rinsing is done only on the lower sections of the drain and rinse screens, thus yielding heavy and dilute medium solutions, the former going to the recirculating sump and the latter to a magnetic separator delivering reclaimed medium to the same sump. Adjustment of the density of the medium is performed by automatically adding water as required to the medium returned to the recirculating sump. At another plant (*Coal Age*, May, 1956, p 69) the reclamation circuit involves magnetic separator, cyclones and a thickener immediately above the coal-cleaning equipment. Automatic valves release medium from the thickener as necessary to keep the gravity of the bath at the desired figure.

Keeping the medium-recovery circuit as simple as possible to minimize capital investment has been the subject of considerable investigation. One plant, using sintering-machine flue dust, which eliminates grinding and recycling at the sintering plant, has simplified the recovery circuit by converting the thickener to a sump; eliminating the magnetizing and demagnetizing coils with no apparent change in the operation of the cleaners; using one drum-type separator per vessel, the product of which is high enough in concentration for delivery to the medium sump without the need of a densifier; and using the separator tailings as spray water on the feed prewetting screens.

Another form of conditioning is removing coal fines from the sand used in sand-flotation cones. The goal is continuous desilting, which is accomplished in one new installation by flowing the sand and water to a German-developed radial screen. The material is fed onto the sloping screens by four revolving arms, and as it flows across the screens is washed with fresh spray water. The oversize, or silt, flows by gravity to the silt sump, while the undersize, or sand and water mixture, is pumped back to the sand circuit.

Fine Coal Washing

With the increase in the use of machines, including the continuous type, for mining, the output of the finer sizes under, say, ¼ in, and the ultrafines under, say, 28M, is increasing. As a result, there has been a corresponding rise in special equipment for cleaning fines and ultrafines in addition to adaptations of the standard machines normally employed for the coarse sizes. The special equipment includes tables (some designed, however, for top sizes of 1¼ to 1¼ in), upward-current classifiers (also offered for the larger sizes) and free-discharge launders.

Cleaning under, say, 28M brings in other and relatively new types of equipment. They include the low-pressure cyclone washer charged with a dense medium; tables operated with a limited top size; jigs, including those with false beds of feldspar or crushed natural material, as well as conventional units operated at low capacity; upward-current machines; froth and matte flotation, the latter using more reagent but able to handle coarser coal and providing a dryer cake; and the bulk-oil process using 5 to 10% of oil by weight and turning out a much-dryer product. Because of the large oil requirements, this latter process is considered more a possibility for metallurgical coal, where part of the oil can be recovered in the coke-oven by-product fraction.

Classification and centrifuging might also be considered fine-coal cleaners on occasion. This results from rejection of the extreme-fine fraction which might carry the bulk of the ash.

Fine-Coal Economics—Installation of fine-coal cleaning equipment does not, of course, automatically provide a profit. For example, if 2% of the output was minus 28M but could be beneficated to make it acceptable, the cleaning would be feasible but the coal would wind up in 5 to 7 tons of water, which would have to be removed at a cost of up to $3 per ton of water. Under such conditions, it manifestly would be cheaper to spend the money to mine fresh coal.

As a modification, if the output of, says, minus ⅛-in was 5 to 6% it might work out that the 1 to 2% of, say, minus 48M, could be discarded because of the extra cost of drying, making possible the recovery and cleaning and drying of the remainder at a profit.

Froth Flotation

As coal and refuse particles get smaller and smaller, their ability to move as desired through water or other washing medium becomes less and less until a point is reached where separation cannot be accomplished on the usual basis. The practical line of demarcation is somewhat indefinite, although the minimum so far suggested for heavy media, for example, is 1 mm, with ½ mm as a possibility. At that point, somewhere around 10M or less, a different principle of separation must be employed to get maximum efficiency with reasonable capacity.

Flotation achieves these goals by adding a reagent to water and then inducing the formation of bubbles. Refuse particles will not stick to the bubbles but coal particles will and are carried to the top of the bath and removed for subsequent dewatering, or other treatment, and loading or mixing.

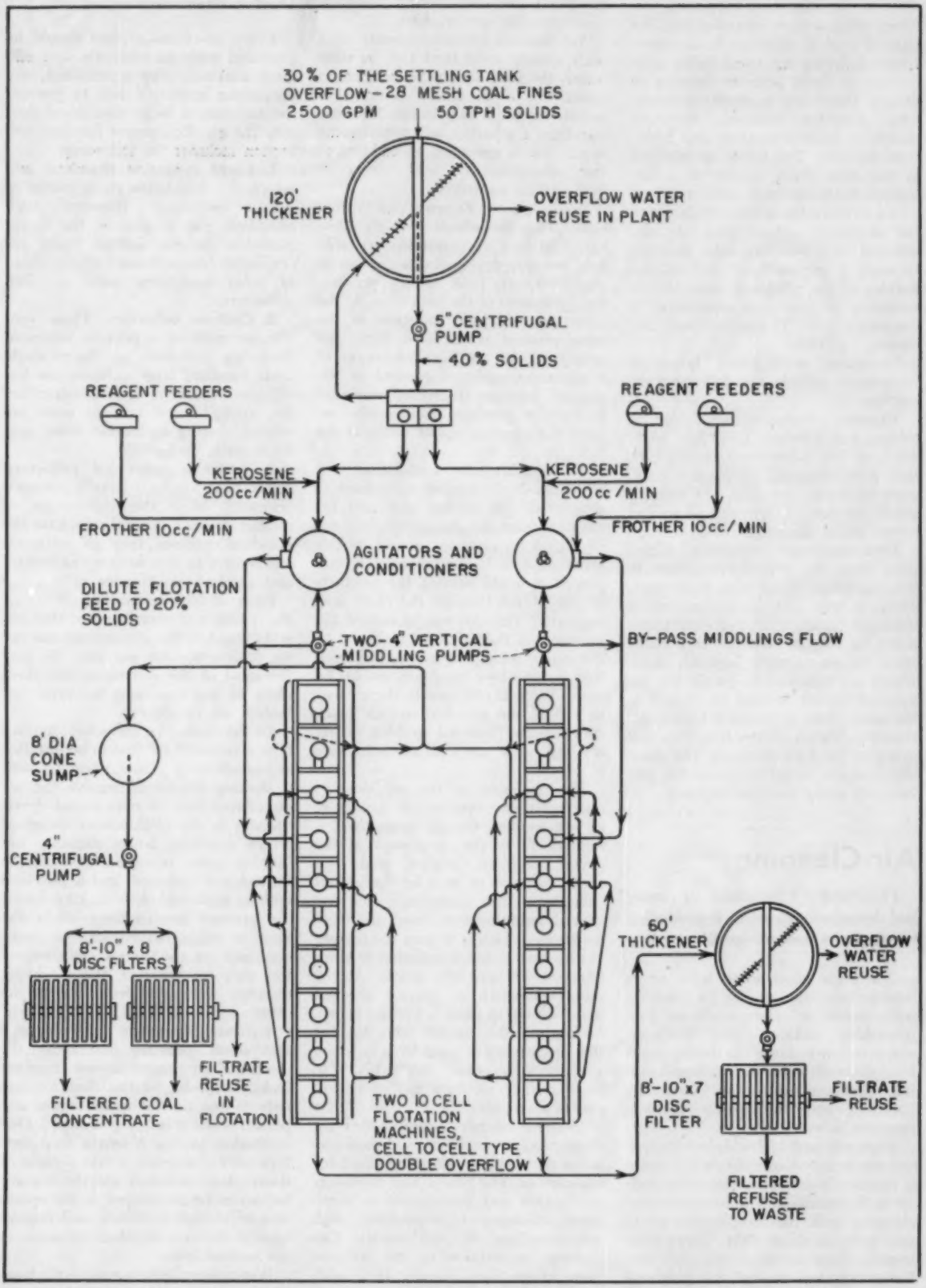
Facilities involved in flotation normally include a thickener or hydraulic classifier to size the feed, remove oversize, and so on; reagent feeders and conditioners where the reagent and the coal pulp are mixed and "conditioned"; and the flotation units themselves. The flowsheet also may be modified to include, for example, roughing cells preceding the final treating cells, retreatment units for a coal or primary tailing product from the primary bank of cells, or other modifications.

Two flowsheets showing, in one instance, the conventional setup for minus 28M coal, and in the other matt›-type equipment for minus ⅛, are reproduced in the accompanying illustrations (*Deco Trefoil*, May-June, 1957). In the 28M installation, retreatment is achieved by returning the discharge of certain cells to cells earlier in the series.

The minus ⅛ installation is an example of a relatively simple flowsheet which accomplishes efficient recovery at a low ash content. The coarser fraction facilitates subsequent dewatering. Primary refuse is screened at 35M, and the plus 35 is retreated in a secondary flotation unit, followed by screening of the tailings and final treatment on a table. All the refuse is collected in a thickener for water reclamation. The underflow may be filtered if required or desired.

Desliming

Since leaving the extremely small



FLOTATION SETUP for minus 28M coal using parallel flotation machines with middlings retreatment and following up by filtering both clean coal and also refuse fraction before final discharge to the bank.

sizes in the raw feed frequently reduces efficiency in cleaning the fine sizes of coal in addition to adversely affecting drying the trend today is to deslime or desilt prior to cleaning or drying. Desliming or desilting equipment includes cyclones, hydraulic classifiers, hydroseparators and bowl-type desilters. The latter, as installed at one new plant, consist of a flat-bottom thickener tank with revolving plows to move the settled solids out to the periphery, where they are discharged to a standard rake classifier through a segment cut out of the bottom of the thickener tank. For a summary of how this equipment is employed, see "Thickening and Desliming," p 149.

Desliming with other types of equipment include the following examples:

Classifier desliming silt prior to tabling and flotation (*Coal Age*, May, 1955, p 78). Classifier size is 65 ft, and it is designed to handle 7,400 gpm of water carrying 188 tons of solids per hour. It removes 39 tons of minus 200M slimes per hour.

Hydroseparator removing minus fines from No. 5 buckwheat feed to flotation plant (*Coal Age*, November, 1954, p 96). The hydroseparator is followed by a classifying conditioner using a conical section and baffle plate to concentrate high-ash fines, which are removed by an air lift. An upward-current washer for No. 4 in the same plant is preceded by a spiral classifier, the underflow from this unit going to the flotation plant. The plant also features launder screens for preliminary sizing and conditioning.

Air Cleaning

PURPOSE: Elimination of water and drying complications in producing low-impurity uniform-quality coal.

The basis of cleaning with air is substantially the same as for cleaning with water or other mediums (see preceding section). Air, however, eliminates or reduces the drying problem, although it involves a dust-handling problem similar to the water-handling and clarification problem involved in wet washing.

High-ash and high-sulphur impurities are removed completely but there is practically no bone separation with air as the medium. The lower limit of cleaning with the most-used type of unit today is about 48M. There is no improvement in ash below this size but at the same time all the finer coal is available for mixing with the clean coal, meaning 100% recovery without the sludge and dewatering problems accompanying wet washing.

Air cleaners normally operate on a fairly closely sized feed and, as with water, the feed should be uniform in quantity and as nearly uniform in impurity content as possible. Moisture variations are particularly troublesome in air-cleaner operation, in addition to the effect—usually less severe—of high surface moistures.

Predrying — Present practice in eliminating the effects of high moisture and lack of uniformity in table feed is to pre-drying, and a number of plants recently built include pre-drying equipment of the heat type. At the same time, if total moisture in the mine product normally is high, the operator gains the sales advantage of a minimum moisture content in the shipped product. Increased moisture in the raw product, incidentally, reflects the growing use of water at the face.

To simplify the installation and eliminate duplication of equipment to supply air for drying and also for cleaning, one installation employs the drying air for cleaning as well. In this installation, a heat exchanger is employed to avoid passing the products of combustion through the cloth dust separator. The aim was to reduce the moisture of the raw coal to less than 4%, under which experience indicated that satisfactory cleaning could be done. With 25,000 cfm to the cleaner at 195 F, the raw-coal surface moisture was cut from 4.4 to 3.6% in one test run at a raw-coal cleaning rate of 60 tph.

The majority of the air cleaners installed today operate on coal ½ in or less in size, though larger coal is treated. From the standpoint of the drying problem, washed coal over about ¼ or ½ in may be dewatered sufficiently for acceptance without special equipment—at least in many instances—which is in part the reasoning leading to the installation of combination wet and dry plants. And if mine conditions or mining practice make drying of fines desirable, it may be accomplished to the advantage of the air-cleaning process by pre-drying as previously noted. Normally, 2 to 2½% surface moisture in ⅜- or ¼-in coal is about ideal.

Most air cleaners now installed are three-product machines, and thus normally provide a middlings product for retreatment. The goal in this middlings production and retreatment is maximum efficiency in separation with minimum loss of coal values. Dedusting to remove up to 50% or more of the fines—usually 48M—adds significantly to normal air-cleaning efficiency.

Dust Collection

Every air-cleaning plant should be provided with an adequate and efficient dust-collecting system—not only for better operation but to prevent the emission of large volumes of dust into the air. Equipment for dust collection includes the following:

1. Large expansion chambers into which the dust-laden air is routed to permit settlement. However, such chambers can trap only the larger particles. Smaller baffled units are employed, however, for scalping ahead of other equipment such as cloth collectors.

2. Cyclone collectors. These centrifugal units are a popular means of removing dust from air. Since single units handling large volumes are less efficient because of reduced air velocity, multiple and tandem units are offered, raising separation from, say, 85 to 95%, up to 98%.

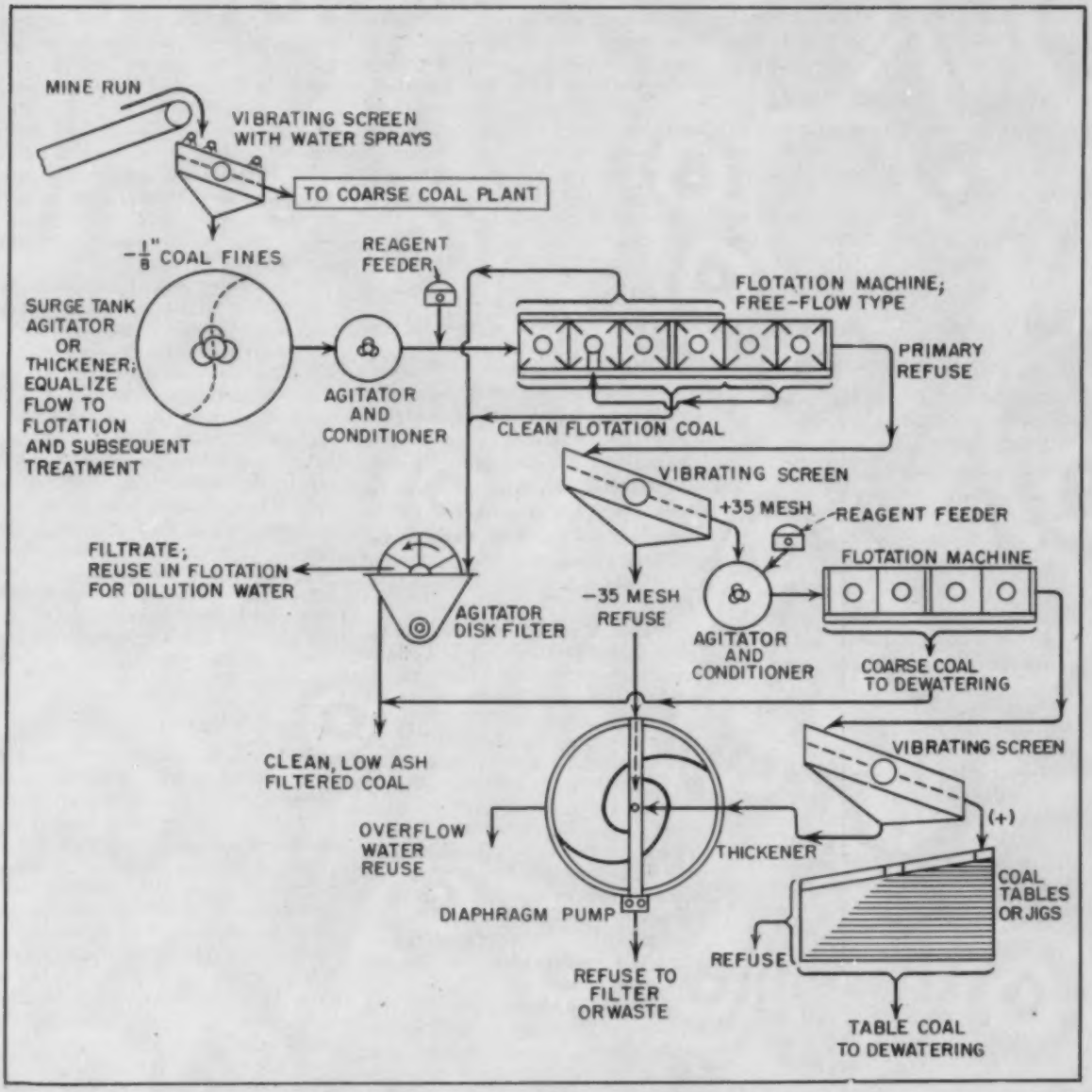
3. Turbo - centrifugal collectors. Turbo-type units, usually termed "clones," offer the advantage of smaller size as a general rule. Like the standard cyclones, they are relatively inexpensive to buy, are easy to operate and are low-maintenance units.

Even at 98% separating efficiency, the quantity of very fine dust that can still escape to the atmosphere can run up to several tons per day. To trap the most of this remaining fine dust, cloth or bag-type and wet-type collectors are employed.

Of the cloth-type collectors, the bag type was one of the first to be installed at coal-cleaning plants, normally with a shaking device to remove the accumulated dust. A more recent development is the cloth-screen collector, which provides larger capacity per unit of space occupied, is easier to inspect and maintain, and is provided with an improved cloth-shaking device To prevent interruptions while the dust is being shaken off the units, dual-unit, or continuous cloth collectors may be installed, the air being directed alternately from one to the other.

Exhaust operation of dry-type equipment keeps the dust within the ducts and equipment in case there are leaks. Disposing of the dust requires care to see that it is not again dispersed when it is being dumped. One method is to run it into a final wet-type unit to convert it into a paste or slurry. Acid, abrasion and the like are factors to be considered in the operation of cloth-type filters, and require special cloths and other measures to get normal life.

Wet-type collectors include the tumbler; a combination of turbo-centrifugal unit and water sprays; and the



COAL UP TO 1/8 IN is treated in this flotation setup using machines designed for the service. Clean coal refuse are filtered and thickened, and provision is made for final tabling or jigging of tailings.

hydrostatic. All have the advantage of high capacity in relatively small space, in addition to a high separating efficiency as a result of the use of water, particularly in the tumbler and hydrostatic units, where the dust-laden air is passed through a water bath. Both units have no moving parts.

A new unit in the form of a cylinder comprises a wet-impingement screen, turning vanes, chambers in the walls to receive the air and water particles thrown out by centrifugal force, straightening vanes and an exhaust fan. One-tenth to one-twentieth the size with high efficiency is among the claimed advantages.

Retreatment

PURPOSE: Increase the ability of the washer to do a sharp separating job by relieving it of part of the load, particularly where the percentage of near-gravity material is high and consequently the cleaning problem is more difficult.

Steps in the retreatment of coarse coal are as follows, starting with a product from the primary washer draw or a special middlings draw:

1. Preliminary screening of the product at 2 in or other limit.

2. Crushing of the oversize to the screening limit to release the impurities.

3. Recirculation of the crushed product to the washer or to a separate retreatment unit. Separate retreatment units are employed where several units handle primary cleaning or where, even after crushing, the recirculated product contains considerable material close to the washing gravity.

With the smaller sizes, particularly less than, say about ¼ in, where crushing is often less effective as a means of releasing the coal values, the entire draw product may be re-

circulated or retreated in a separate unit. This is particularly true in air-cleaning coal under approximately ½ in.

The value of this method of enhancing cleaning efficiency and reducing coal loss is evidenced by the increasing use of separators designed to produce three products: clean coal, middlings and refuse. This has been particularly evident in cleaners of the heavy-media type.

Salvage

PURPOSES:

Reclamation of coal that otherwise would be lost because it never gets to the preparation plant, or because the preparation system is set up to reject it without an opportunity to get it back.

Recovery of coal from primary washer rejects left in because of a desire to get sharper separation or because of washer overloading resulting from a change in coal and refuse character or the need for more tonnage.

Examples of salvage operations include the following:

1. Crushing and washing of pickings, either in regular or special units, to save coal values.
2. Picking out, crushing and loading separately for steam coal a bony product that might otherwise go to refuse.
3. Processing of roof brushings, track cleanings and the like to recover a regular or a steam-coal product. As an example, one plant producing metallurgical coal set up facilities for treating top brushing, which included a rider seam, the product being used for steam raising. Normally, the production of such material should be sizable to warrant separate facilities.

Recovery from primary washer reject also follows, as a rule, the standards of preliminary screening to take out fines and crushing to release interbedded material, although the reject may be treated as it comes from the primary units. The latter, however, usually is less efficient and does not give as good a recovery.

Another form of salvage, widely practiced in anthracite and to a limited extent in bituminous, is reworking contents of old refuse banks and silt ponds or dumps.

Salvage operations ordinarily are carried on with conventional screening, crushing and cleaning equipment. Exceptions include the use of rock-type screens and crushers, and extra-large draws on cleaners where mine material or pickings containing large percentages of rock are processed. One highly desirable characteristic of a salvage cleaner is ability to handle a wide range of feed, both in refuse content and in quantity, since there is less opportunity for stability in either role or characteristcs in the average salvage work.

Clean-Coal Sizing

PURPOSE: Separation of the product of cleaning or other processing operations into the final or semi-final size group for loading, or for loading plus additional treatment of a certain size fraction. This treatment may include rescreening, crushing and rescreening, and so on, plus mixing and blending, discussed in later sections of this Guidebook.

Clean-coal sizing, or classification, is handled by both shaker and vibrating equipment, the latter having made substantial gains in this field as well as in the field of raw-coal sizing. Certain factors involved in clean-coal sizing are substantially similar to those in raw-coal sizing. In addition, accuracy becomes vital, not only because of its effect on the buyer but also because inaccuracy can materially affect realization by putting larger sizes into smaller. This in turn brings in questions of plate and cloth wear, blinding, and so on. Also, screening should be done to keep degradation in the process to a minimum.

Shakers and vibrators are the old-reliables in clean-coal as well as raw-coal screening. Among the new types finding application in the U. S. are the radial (*Coal Age*, September, 1953, p 95; September, 1956, p 78), and the upright curved-deck screen (*Coal Age*, August, 1956, p 98).

Accuracy Factors

Aside from moisture and blinding, accuracy involves time the coal is on the screen surface, and also cloth or plate wear. Thus on the screen brings in the question of breakage, or degradation, which increases with increased screening time, though as in anthracite, the hardness of the coal may permit a longer retention time without increase in breakage. Of course, other things being equal, sufficient time must be provided to permit the smaller sizes to work down and be separated out, and in turn this brings in the question of bed thickness. It should not be excessive if good screening is desired, and the smaller the opening the less the bed thickness should be if excessive length of screen is to be avoided. Where one of the products is screenings and the feed to the unit includes all sizes up to lump, depth of bed should not be more than 4 to 6 in, and screening efficiency and capacity may be increased by placing a large-hole relief screen over the slack section.

The relative ease or difficulty of screening a certain feed at a certain size, which in turn is one measure of the screen area necessary for accurate separation, reflects in the main the quantity of near-opening material in the feed. If there is a substantial percentage of material at or slightly larger than the opening size, particles smaller than opening size find it more difficult to work down through the bed of near-opening material, and also there is a greater chance that particles only slightly undersize will be carried beyond the screening surface before they have an opportunity to go through. The difficulty increases as the size at which screening takes place decreases.

Screen Wear

Plate, cloth and wire wear reflect load, screening time, abrasive nature of the material, corrosion if the water is acid, and the material used in the screen. Where plain-steel plate is employed, increasing the thickness is one way of offsetting the effects of wear but brings a significant decrease in screening efficiency. Consequently, operators turn to bronze and alloy steels, with stainless coming rapidly to the front in recent years for the smaller sizes. However, as a general rule, stainless life must be 10 times plain-steel life to justify its use for wear resistance alone, and therefore bronze or other alloys are favored for heavy plate. With round-rod or wire screens, or with special-profile bars, wear is largely on the top and consequently the period of reasonable accuracy is materially lengthened.

Small-opening punched plate must be relatively thin, both to facilitate the punching operation and because excessive thickness, as previously noted, affects screening efficiency. Consequently, additional support is required to prevent sag and wear. Bars under the plates are the preferred method. An alternative is the Perister-tread screen—a stepped-type unit in which the risers provide the extra support while the screening is done on the treads. Bars or other supports also are installed under the cloth on vibrating screens.

Elongated openings frequently are employed instead of round or square. Among the goals are: (1) increased screen capacity, (2) reduced blinding and (3) less breakage with friable coals. However, replacing conventional screens with long-opening units, with no change in the effective width of opening, normally increases the size of the through product. In other words, it enlarges the effective opening.

A special form of screen is the lip type, usually with a greater width at the lower end of each opening. It provides a tumbling effect and this, together with the type of opening, normally results in an increase in capacity of up to double or more. At some plants this characteristic has resulted in installation of lip screens to offset a condition of chronic overload. Incidentally, overloading severely affects screening efficiency. For maximum accuracy, feeders or other devices should be provided to insure uniformity in rate of feed to screens.

Use of elongated, lip and similar screens brings in the factor of separation by shape as well as by size. Consequently, the products are quite different in character, with considerably more flats in the underproduct with the elongated-opening units.

Excessive flats may be considered a detriment in coal for domestic use. Anthracite is confronted more with this problem than bituminous. Flats may be picked out by hand or, where the quantity is large, mechanical pickers may be employed. These may consist of angles with a gradually increasing opening from feed to discharge end; small-diameter motor-driven rolls (several side by side); and special punched plate with narrow slots into which flats will slide but not the normal lumps.

Blinding—Cause and Elimination

Blinding in coal screening occurs with all sizes but is particularly annoying and most affects efficiency with the smaller material. Blinding reflects in the main the percentage of particles near the size of the screen opening and especially, as the size of the coal decreases, surface moisture.

Additional factors tending to increase blinding include overloading and the presence of clay and shale mud. As a rough rule, a surface moisture of 6% will result in complete or nearly complete blinding at separations of ¼ in or smaller. At 2% or less, little or no blinding occurs.

Aside from blinding, moisture also tends to increase the inaccuracy of screening by causing small particles to stick to larger pieces. Where washing is done, one of the functions of sprays on classifying screens, in addition to opening up and agitating the bed to facilitate separation, is washing the fines off the large pieces and through the screen.

The building up of a film of moisture and packed fine material is held to be the major cause of blinding in fine-coal screening. Time is a second major factor. Rust and corrosion with plain steel also can cause major blinding difficulties, especially after the screen has been idle for a time.

Electrical heating is rapidly growing as a means of preventing blinding of screen cloth. Other methods applying to cloth, plate or both, include:

1. Alloy metals which resist wetting and film buildup.
2. Use of plate, wire and cloth impervious to or less subject to rusting and corrosion.
3. Use of large openings, though this brings in the risk of throwing more oversize into the through product.
4. More screen area or a lower feeding rate with higher moisture.

More fundamental, perhaps, are mixing and blending to achieve uniform surface moisture or predrying of moist or wet material.

Screen Heating – Heating cloth electrically is rapidly growing as a means of preventing blinding. Most screen manufacturers are now in position to offer designs applicable to practically all types of screens. In addition to eliminating blinding and its attendant effects, including the necessity of increasing screen opening, heating also offers two other advantages:

1. Increased screen output—up to 50% or more.
2. Longer screen life—up to 4 or 5 times in some instances. Also, some operators have found that they can get increased life with smaller wire and less costly cloth.

Heating, however, like other methods of preventing blinding, will not prevent wedging of near-size particles in the cloth nor clogging when the depth of the bed on the screen is greater than recommended practice.

Power cost for screen heating at one installation, 6x14-ft double-deck units, ¼ x ⅝ final openings, was ¼c per ton, which was more than offset by eliminating hand cleaning following blinding, and by an increase in screen life from 560 to 2,000 hr.

Degradation Removal

Screening out of small pieces resulting from breakage in processing, sometimes called rescreening, can take place at convenient points in the operation. Usually, however, it is done immediately ahead of the loading boom or chute, generally by a separate section of screen in the sizing shaker or in the chute leading to the boom.

Dewatering and Drying

PURPOSES:

1. Reduction of moisture in the final product and enhancing the benefit to the consumer, particularly in the industrial category, by raising Btu content, reducing freight cost, or better fitting the coal for such uses as the production of metallurgical coke.

2. Elimination of freezing difficulties.

3. Preparing the coal, by such methods as predrying, for added efficiency in screening, air cleaning and the like, while at the same time securing Benefits 1 and 2.

Because the surface area on which moisture can collect increases rapidly with reduction in size, dewatering presents a greater problem with fines. As a rough rule, natural drainage will reduce the moisture on coal above ½ in and perhaps down to ¾ in to a point where there will be little or no freezing except in very severe climates. However, it may be desirable to reduce the moisture still further for the reasons set out at the start of this section. Below ½ or ¼ in, freeze prevention requires specific dewatering methods and equipment.

Natural Drainage

Equipment employed in dewatering by natural drainage includes hoppers and bins; inclined and horizontal conveyors with screens in the bottom; perforated bucket elevators; and fixed screens. Fixed screens in flumes from washers to classifying screens, in fact, are widely used for unloading a large part of the water.

The fixed-screen principal for unloading or reducing excess water has been developed into special types of units both here and abroad. The launder screen recently developed for anthracite is made by placing 6-in-high partitions every 6 in along a chute or launder pitched at ¾ to 1¼ in per foot. Screen cloth is tacked over the compartments, which are drilled in the bottom to receive pipe bushings. Only a small percentage of the water and fines is removed in each

compartment, resulting in more-even water distribution over the entire screen surface. Also, the bed is maintained in fluid condition, resulting in high screening efficiency.

A combination of "partitioned" and "radial" screens is used abroad and is now offered in the United States for preliminary dewatering of minus ¼-in coal prior to centrifuging (*Coal Age*, September, 1953, p 95). High efficiency with high capacity are claimed for the combination. The radial screen alone also is being used at one plant (*Coal Age*, September, 1956, p 78) to recover plus 28M coal from the underflow of a clean-coal discarding screen. The recovered coal is returned to the feed and the sand and water to the cone circuit.

Belts, as at one U. S. plant, may be used for removing a portion of the water by natural drainage. The belt may be humped in the center, or may be inclined with the coal on the side to permit the water to run back over the tail pulley.

For coal larger than ¼ or ⅜ in, dewatering by natural drainage is quick and complete, and the product, as noted, normally will not freeze unless the cold is severe and lasting. Where the finer sizes are involved and freezing is a consideration, the problem becomes more difficult. However, natural drainage of coal as fine as 1/16 in and 28M to surface moistures of 10 to 12% is being achieved with flotation coal.

Mechanical Dewatering

Omitting such processes as thickening and the like (see later section in this Guidebook), mechanical dewatering, frequently set up to complete the job in one pass, is done by screens, centrifuges and various forms of filters, the latter including the high-frequency electrically actuated vibrating type. With all, the dewatering process, as with fixed screens, normally involves producing a through product which must be loaded wet, discarded or treated by other means. Some special forms of mechanical dewatering include squeezing flotation coal on a belt by an idler-pulley.

Shaker Screens—Conventional shakers of course accomplish dewatering, but when dewatering is the specific goal the tendency is to go to special screens, usually flexible-board-hung or supported and operated at speeds of 150 to 400 rpm, with short throws of around 1 in. Anthracite shakers for both dewatering and sizing tend to operate at nearly conventional speed and stroke but with only a slight inclination, usually ¾ in per foot. For dewatering only, the speed is increase to 200 to 400 rpm and the throw is cut to 1 to 1½ in, especially for the smaller buckwheats.

Plate or cloth may be used in dewatering the larger sizes, and plate also is employed for a substantial portion of the smaller sizes in anthracite. In bituminous, however, when dewatering at, say, 28M, the tendency is to use cloth, rod or wedge wire.

When used for dewatering, the shaker-type screen normally will reduce the surface moisture of sizes above approximately ¼ or ⅜ to 5% or less. When dewatering smaller sizes at, say, ½ mm or 28 M, surface moistures of as low as 3% have been obtained, but the range usually is 5 to 10% and higher.

Vibrating Screens—When used within their limitations, vibrating screens provide real advantages in the field of dewatering. Initial, operating and maintenance costs are low, and a high removal of solids from wash water is achieved with a minimum of effort. Since operation in a nearly horizontal position is necessary, it usually is desirable to have a high operating speed and a stroke at an acute angle with the screen deck to facilitate the conveying action, which normally is slightly uphill.

Width and length of screen should be selected for proper handling of the expected quantities of water and solids, with especial attention to keeping the width narrow enough to maintain a bed at all times. Dams in the center and at the discharge end help both in maintaining a bed and in promoting water removal through longer retention of the coal on the screen. However, dams should not be high enough to result in excessive bed thickness.

The bulk of the water should be removed on the first half of the screen for best results, and a bed of the requisite thickness should be formed as soon as possible to prevent excessive loss of the fine sizes. Unloading of as much water as possible before the coal is placed on the screen helps, and if fine sizes from some other unit are added they should be placed gently on top of the bed after it is formed. Size distribution of the primary feed should be such that it will form a bed.

Dewatering results reflect size of coal handled. Where the average size of the feed is around 5/16 in, a surface moisture of 5% normally can be attained, and in many instances much less. Final moisture increases with reduction in size up to 25% or more with, say, 28 or 48M material.

Centrifugal Screens—Now being offered for both dry screening and dewatering of the smaller sizes, the centrifugal screen provides results down to as low as 2 to 3% for coal approximately ¼ in in size in some instances, and normally around 5%

Scalping Service—All types of screens and natural-drainage units may, of course, be used to scalp off part of the water before the coal goes into centrifugal or heat-drying equipment. And by the same token, the feed to screens may be scalped by settling tanks and similar facilities, thus again relieving the burden on the following units and raising their capacity and efficiency.

Centrifugal Driers—Centrifugal driers commonly used in coal preparation are usually divided into the screen and solid-bowl types. In terms of actual tons of water removed per hour, the centrifuge ranks high as a low-cost device. A new unit being offered in the United States includes a "rapper" or "bumper" to facilitate travel of the coal down the screen. Centrifuges normally operate on coal less than ½ to ¼ in in size and provide surface moistures of 5 to 7%, sometimes higher and sometimes lower depending upon the size and other characteristics of the feed. Unit capacities range from 20 to 75 tph, as a rule. Coal loss in centrifuging, again depending upon size consist and character, generally is 20 to 30% of the feed, sometimes less and sometimes more.

The size of the fines fraction affects the results of centrifuging in much the same way as it affects the results of other forms of drying. As an example, solid-bowl units have produced surface moistures of 11 to 13% where the slimes have been included in the feed. In another plant, the same unit, with 60% of the minus 200M material removed from the feed, achieved a cake moisture of around 6%.

Maintenance also has a major bearing on the results of centrifuging. Proportions and clearances are carefully designed for maximum efficiency. Frequent maintenance, rather than letting renewable parts run to destruction keeps the moisture in the output at a minimum and thus increases acceptability without further treatment or makes the cost of subsequent thermal drying appreciably less.

Centrifuges may be employed for the complete dewatering job. However, there is a tendency to use the centrifuge as a scalping unit ahead of heat-drying equipment, thus simplifying the heat-drying job.

Filters—With the increase in pressure to reduce stream pollution, and also as a result of the growing use of other types of mechanical dewatering equipment producing effluents containing fine material, there is an increased trend toward the installation of filters of the continuous-vacuum type. As a corollary, a solid-bowl centrifuge especially designed for the service, known as a "polisher," is used for the same purpose.

Among the vacuum filters the drum type, and especially those with top-feed reservoirs, can handle coarser solids but require considerably more floor space.

Filters receive feed from settling tanks and thickeners, directly from wash-water sumps, and as effluent from other types of mechanical dewatering units. Common combinations are a centrifuge and a polisher, a thickener and a vacuum unit, or cyclones—single- or two-stage—and vacuum equipment. For typical flowsheets, see section on "Water Handling." With the vacuum type, flocculation of the fine-coal particles by means of caustic starch or some other agent increases filter capacity and reduces moisture in the final cake, which may be loaded directly or, in some instances, heat-dried alone or in combination with larger sizes. However, some experience abroad has indicated that starch-type flocculants can result in difficulties in flotation where the filter effluent is recirculated.

Final surface moisture of the filter product is held to reflect largely the moisture in the feed, the percentage of minus 200 to 325M material and the ash content of the dried product, though feed moisture apparently is less of an influence than the other two factors. Depending upon percentage of fines and ash, surface moisture in the product ranges down to as low as 15% and up to approximately 30%, with some exceptions both above and below. For a complete discussion of selecting and operating disk-type filters, including factors affecting filtration rate and moisture removal, see *Coal Age*, January, 1955, p 76.

Thickening and Desliming

Since large volumes of water complicate the final drying job—whether in mechanical or heat equipment—and since very fine material decreases the capacity and efficiency of both mechanical and thermal units, the trend today is toward thickening or desliming, or both, in advance of final drying.

Thickening—Reducing the water load on the final drying units may be done by relatively simple means, common ones being fixed sieves or mechanical or electrical screens—usually both—ahead of the drying unit. For even greater water removal, plus also desliming, the equipment that may be employed includes drag-conveyor settling tanks, thickeners and cyclones, which may be preceded—and usually are—by fixed sieves and operating screens for unloading.

The cyclone has the advantage of low cost and high flexibility. The settling tank also has the advantage of relatively low cost and simplicity but the degree of thickening may not be as great. Sedimentation in relatively still water is perhaps the ultimate in thickening, and is the province of the usual circular thickener. Although their first cost is relatively high, maintenance and operating costs are almost negligible and they produce clear water for reuse. To speed settling or to take care of conditions approaching colloidal suspension, flocculation may be employed. Starch is still considered the most satisfactory medium, though, as previously noted, it may result in trouble if the water is recirculated to flotation circuits. This trouble, however, is not encountered with synthetics, which are finding increasing use.

Settling tanks frequently precede centrifuges and other types of dewatering equipment. Examples of thickening before drying with the settling tank and other types of units include the following:

1. Drag tank employed to recover ¼x0, with 50-ft thickener for minus 60M fines.

2. Settling tanks and 14- and 3-in cyclones used to clarify and recover coal. In addition, by bleeding 98% of the minus 200M, which is impounded, the solids content of the system is kept constant.

3. Silt from tables and flotation equipment, at a rate of 102 tph in 1,440 gpm of water to eight 14-in cyclones; thickened cyclone underflow (101 tph maximum in 900 gpm) to three solid-bowl centrifuges (*Coal Age*, May, 1955, p 78). Desliming at this plant, incidentally (see flowsheet), is done ahead of the cleaning units.

4. Fine coal (¼x0) to drag-conveyor settling tank, with underflow to centrifugal dryer, overflow back to wash box and effluent from top of tank to settling pond (*Coal Age*, June, 1955, p 68).

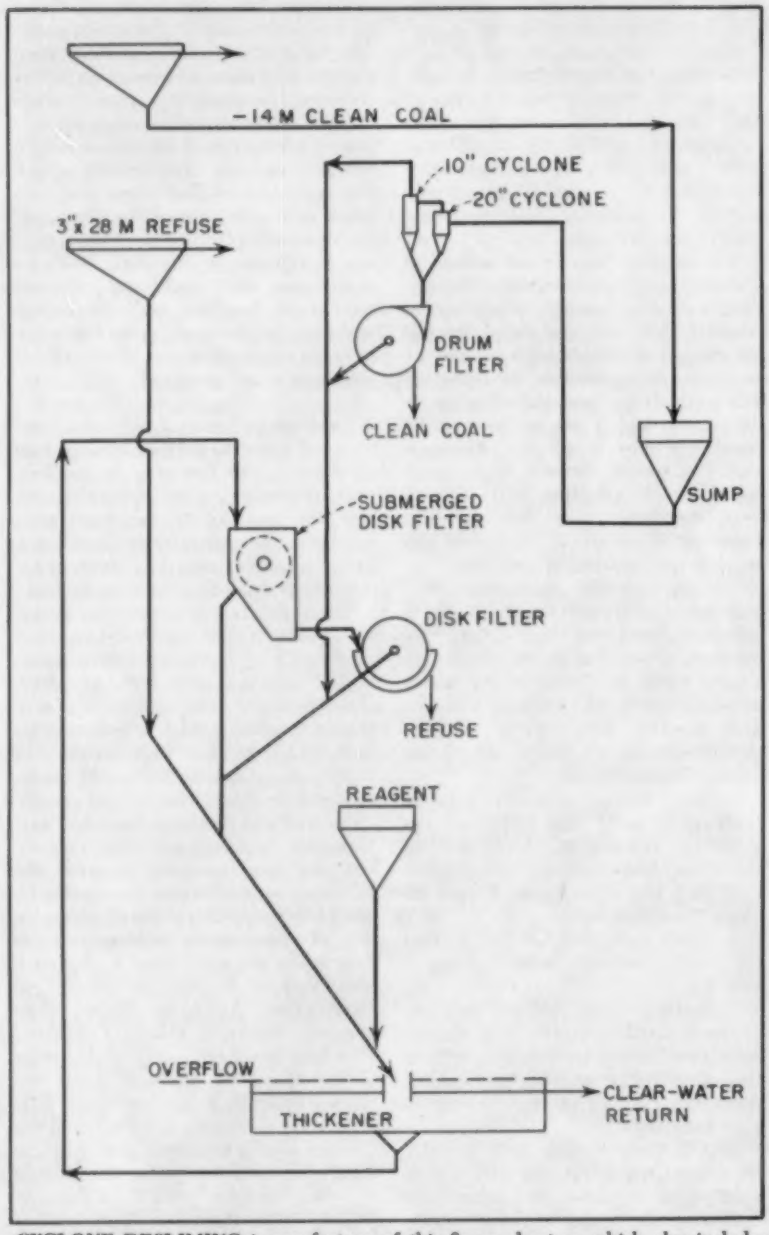
5. Thickening prior to filtering at another plant is handled by a battery of three 20-in cyclones in series with eight 14-in cyclones (*Coal Age*, December, 1955, p 70). The cyclones remove approximately 150M from a 28M feed, and handle approximately 1,800 gpm with a pressure of 35 psi on the outlet side of the 14-in units. The 14x150M cyclone product then goes to two top-speed-reservoir filters reducing moisture to approximately 18%. Cake is stored in a special tub-shaped bin equipped with a boom-type scraper conveyor. The bottom of the bin is shaped so that when the conveyor is lowered onto it the fines may be removed completely. Other drying equipment in the plant includes centrifuges for ⅜x0 and thermal equipment handling both centrifuge and filter products, reducing the moisture to approximately 3½%. Feed moisture is approximately 9%.

Desliming—Removal of very fine material prior to further drying may be done as the first step in the fine-coal processing cycle, or directly before the material to be dried goes into said drier. Removing clay limes, as an example, ahead of froth flotation keeps reagent consumption low.

Desliming before processing at one new plant is done in two bowl-type desilters. The desilters overflow minus 100M, approximately 80% of which is minus 200M. The coal then goes to the table plant, which is followed by four solid-bowl centrifugal filters, with a fifth as a spare. Filter effluent is returned to the clarified-water circuit. "The uniform deslimed feed not only promotes high efficiency in cleaning fine coal, but materially improves the efficiency in mechanical dewatering by solid-bowl centrifugal filters, giving an overall performance ranking with the best in the industry" (Paul L. Richards and Andrew F. Hamlet, 1056 Coal Convention, American Mining Convention, American Mining Congress). The final dewatering step at this plant is performed by thermal driers reducing moisture to approximately 3%.

Cyclone desliming is included in the accompanying flowsheet of a clarification setup also involving flocculation (J. M. Vonfeld, AIME, February, 1956). The 1½x14M clean coal is screened at 14M, with the minus 14M being pumped to 20-in cyclones. The 20-in cyclone overflow then is deslimed in the 10-in units. Underflow from both is filtered in a top-feed drum unit and loaded with the clean coal. Effluent from the small cyclones and drum filter is sent to the thickener with minus 28M refuse, added to improve filtration of the thickener underflow.

The thickener feed is treated with causticized corn starch to increase solids settling rate and improve clarity of overflow water. The thickener underflow goes to a submerged disk filter whose purpose is to permit withdrawal of the underflow with a



CYCLONE DESLIMING is one feature of this fine-coal setup, which also includes flocculation in the thickener.

fairly low solids content without influencing the operation of the final disk unit. This final filter is able to maintain a relatively thick, dry cake—disposed of with the coarse refuse. There is no bleed, and the overflow from the thickener is returned to the table plant as dressing water. It is clear, facilitating observance of table operation.

Warm-Water Processing — Experience at a number of plants indicates that the efficiency of mechanical dewatering by screens, centrifuges, etc., is higher in summer when the water temperature is up. In other words, the water is easier to shake or spin off. Advantage is taken of this fact at one plant (*Coal Age*, December, 1955, p 70), where dust is removed from the drier exhaust by a combination of cyclone collectors, and water sprays are used to cut down the speed and volume of the first exhaust to the atmosphere. Four thermal driers each exhaust 50,000 cfm at 200 to 250 F. The exhaust carries with it 14Mx0. Two cyclones are provided for each of the four drier exhausts, after which the gases go to a concrete duct leading to a silo chimney. Sprays in the concrete duct reduce gas temperature from approximately 180 down to 110 F. The warmed water, with its temperature raised about 45 F, is returned to the fine-coal . washing circuit, raising its temperature by up to 13 F in winter. This warmer washing water and resulting warmer coal facilitates mechanical dewatering, apparently by reducing surface tension.

Heat Drying

Heat drying is about the only way to get surface moistures of as low as 2 to 3% consistently, particularly with the finer sizes. In this process, the coal is subjected to hot gases at temperatures slightly above the temperature at which volatile matter is distilled off of the coal. Time is a major factor in preventing distillation, or coking, of the coal and consequently the aim is to keep it as short as possible, though longer periods are possible with reductions in temperature.

Types of heat driers used in coal mining are:

1. Rotary, with either inner and outer shells, or an outer shell with lifting vanes inside.

2. Screen involving a reciprocating screen as the carrying medium. In most instances, the gas is pulled down through the bed and the drying action is of two types; evaporation and, to some extent, mechanical as a result of the screening action and the scrubbing action of the gas. When the gas flow is interrupted by an appropriate valve and then is resumed, squeezing also takes place. As the coal gets finer, evaporation becomes relatively more important, and consequently, fine-coal screen driers are designed for longer coal retention as a rule. New designers include a step between the two screens to turn the coal over.

Depending upon size of the unit, also the size of the coal, capacities of screen-type driers normally range from 25 to 125 tph of dried product.

3. Cascade, in which the coal flows in steps down through a vertical shell, resting for an interval on each shelf or step in one type and on a bottom shelf in another.

4. Conveyor or carrier, in which the coal is moved through a hot-gas chamber on a perforated carrying strand or a wire-mesh belt. One type provides two stages of drying with both up- and downdraft gas flows, the down being the second stage and designed to permit maximum mechanical dewatering through the wire-mesh

belt. The coal bed in the second pass also acts as a filter to catch dust from the first pass.

5. Suspension, in which the coal is introduced into an upward-flowing stream of gas. In one type, the coal is placed in the gas at the bottom of a drying column. Drying takes place almost instantly and the coal is separated out in a cyclone collector equipped with a rotary discharge valve. In another type, the coal flows down over the flights of an inclined conveyor and at the same time is moved sideways to the discharge point. Housing design is such that only the smallest particles escape from the chamber. Both driers are widely used for the finer sizes of coal.

6. Fluidized-bed, in which the coal is dried in a reactor in a fluid state. Bed temperature can be closely controlled by injection of air into the stream of drying gases. In the first installation, with a feed of 85 tph, $\frac{3}{16}$x0, 11% surface moisture, the final product averaged 2% surface moisture with a fuel consumption of 1 ton (*Coal Age*, July, 1956, p 76).

Dust Suppression—Dust is a problem with practically all heat driers, and particulary with those handling the smaller fines. Cyclones are the first line of defense and may be supplemented by bag-type collectors, wet collectors and water-spray systems (see section under "Air Cleaning"). High temperatures and high moistures in the spent gas have militated against the use of bag collectors in some instances and resulted in adoption of wet or wet-and dry (tumbler-type) collectors.

The problem of disposing of the collected material has been solved in at least one instance where water-spray equipment was installed by cleaning it in flotation equipment and dewatering it on a vibrating screen. At another plant, the primary dry cyclone product is used for drier-furnace feed or is included in the shipped coal, while the exit gases are polished up in wet "clones." The spigot product of the wet units is pumped to refuse.

Dryer Safety — Ten recommendations by the USBM for promoting safety in the operation of heat dryers (R.I. 5198) are:

1. Good housekeeping should be stressed to prevent spread of combustible dust and eliminate ignition sources. Adequate vents should be provided, not only on cyclones but on other equipment and in the main structure of the plant.

2. Automatic controls—preferably with alarms—should be provided to shut down equipment if the temperature rises excessively, coal feed is interrupted or gas flow is interrupted.

3. Moisture content of the coal fed to the dryer should be maintained at a uniform level.

4. Temperature charts should be carefully watched and dryer operators should not tamper with equipment or controls.

5. Controls, valves and other sensitive parts should be inspected frequently.

6. Equipment should not be operated beyond rated capacity and definite upper limits should be placed on permissible inlet and outlet temperatures and the rate of coal feed.

7. Scrubbers and collectors should be placed beyond the cyclones to prevent excessive discharge of dust.

8. Adequate fire-protection and fire-fiighting equipment should be maintained in the drying plant.

9. Long ducts, and especially horizontal ones, should be avoided to minimize ignition hazards and reduce surfaces on which fine coal can accumulate.

10. All dryers, conveyors and other dust-producing equipment and transporting machinery should be made as dusttight as possible and operated to prevent dust leakage.

Crushing

PURPOSE: Conversion of unwanted or slow-moving natural coarse sizes into smaller sizes desired by the market, as distinguished from crushing for process purposes, such as middlings retreatment.

Although crushing or breaking for market purposes can take place in the preliminary processing, as in reducing the top size in the mine-run feed to a certain dimension, the majority involves specific sizes after hand picking or other cleaning, and the goal usually is the production of stoker or other smaller sizes. An exception is anthracite, where practically all of the breaking is done in one or more stages before the coal goes into the cleaning units.

In bituminous plants, a favorite place for cleaned-coal crushing equipment is between the top and bottom strands of the mixing conveyor. This permits a wide flexibility in the size that may be run to the crusher, and also provides a convenient means of getting the crushed product back to the loading point, especially when the product is loaded without further sizing or other treatment.

Crushing may be—and frequently is—a part of a breaking and rescreening cycle for the production of double-screened stoker or other sizes, such as pea (see "rescreening").

A major goal in clean-coal crushing operations—or, in preliminary breaking for the same purpose—is reduction to the proper size without excessive production of fines. Crusher design is one answer, and types and models now available permit good attainment of this objective. Operation is another answer and, among other things, involves stage crushing with rescreening between each stage. Some plants use as many as three or four crushers in series with vibrating screens between to unload the fines, which otherwise would result in increased grinding and pulverizing.

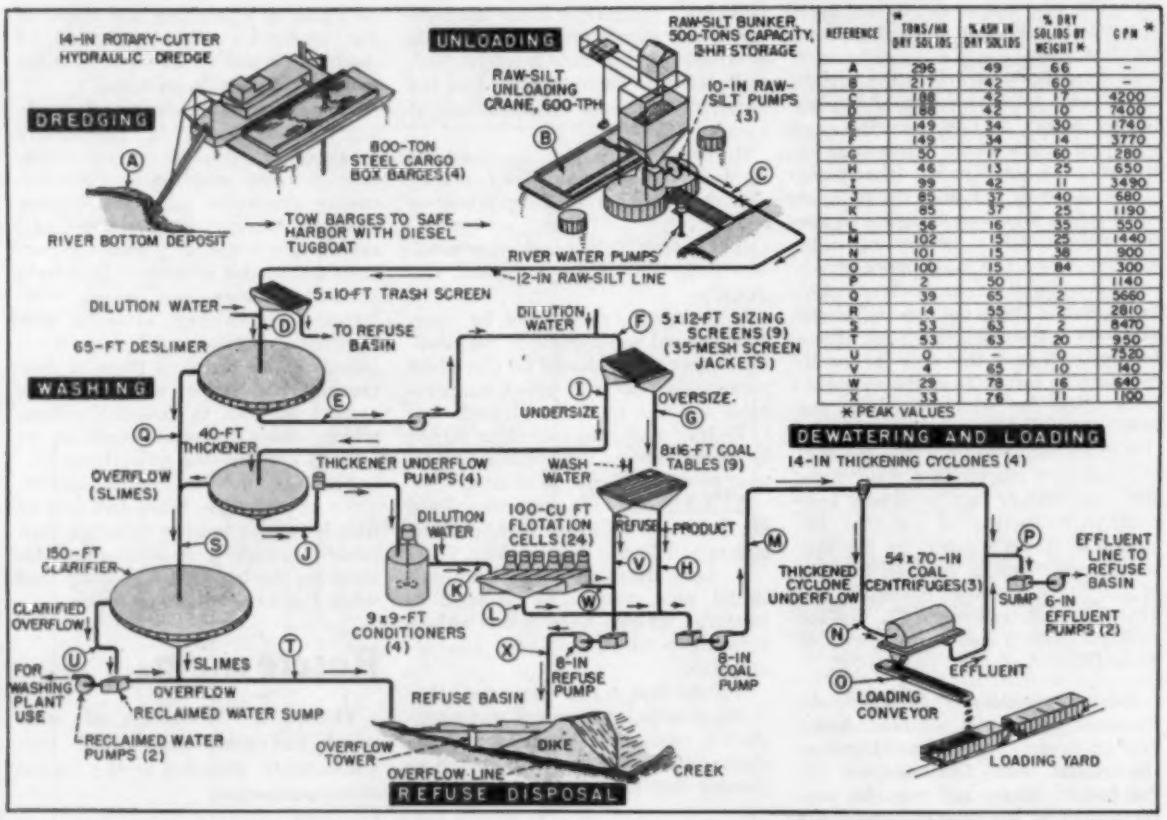
Flexibility in sizes shipped may involve considerable labor and loss of time in varying crusher openings. New models provide gear mechanisms for attaining such changes quickly and while the crusher is in operation.

Rescreening

PURPOSE: Production of additional and sometimes special sizes not normally provided by the regular sizing equipment.

The growth of the domestic stoker was in large part responsible for the growth of rescreening in the bituminous field. With a longer size list, anthracite, in contrast, had no need to change its practice, beyond doing additional crushing, to satisfy stoker customers. Making bituminous stoker normally involved at least dedusting or the removal of fines under, say, ¾ in. Also, many mines going into stoker the problem of making a product with a top size of ¾, 1 or 1¼ in out of, say, 2-in screenings. Thus, rescreening received a large part of its momentum and the process then was broadened to provide what might be called specialty sizes for other purposes.

The vibrating screen, normally receiving its feed from the main sizing shaker, is the most-used type of rescreening unit in the bituminous fields. Air also has been used for dedusting at, say, 48M, in making the smaller stoker sizes. Rescreens also are quite commonly hooked up to receive material from cleaned-coal crushers when the natural output of the mine is not sufficient to meet stoker and other specialty demands. Over and through products from rescreening may be sold as separate grades but more commonly are run into slack and screenings shipments for industrial purposes.



REFERENCE	* TONS/HR DRY SOLIDS	% ASH IN DRY SOLIDS	% DRY SOLIDS BY WEIGHT *	GPM *
A	296	49	66	-
B	217	42	60	-
C	188	42	17	4200
D	188	42	10	7400
E	149	34	30	1740
F	149	34	14	3770
G	30	17	60	280
H	46	13	25	650
I	99	42	11	3490
J	85	37	40	680
K	85	37	25	1190
L	56	16	35	550
M	102	15	25	1440
N	101	15	38	900
O	100	15	84	300
P	2	50	1	1140
Q	39	65	2	5660
R	14	55	2	2810
S	53	63	2	8470
T	53	63	20	950
U	0	-	0	7520
V	4	65	10	140
W	29	78	16	640
X	33	76	11	1100

* PEAK VALUES

DESLIMING MAY BE DONE TO INCREASE both cleaning and dewatering efficiency in handling fine coal. In addition to desliming, cyclones are used for preliminary dewatering prior to final drying in this plant.

Mixing and Blending

PURPOSES:

1. In blending, to achieve a high degree of uniformity of ash, sulphur and other constituents in the finished product. Blending is done mostly where metallurgical coal is involved and, as previously noted, is accomplished largely at the raw-coal end. However, some metallurgical plants also blend the cleaned product a second time before loading.

2. In mixing, to provide sizes better tailored to the needs of the consumer.

Most of the mixing is done on the old reliable mixing conveyor. Unless crushing is introduced into the circuit, the mix is a natural one—in other words, the sizes in the mix are present in the percentages that naturally come from the final sizing screen.

"Prescription" mixing is a relatively new method of achieving a size consist in line with the customer's desires. A major advantage is that the consists can be absolutely accurate and also absolutely uniform.

Prescription mixing normally is limited to the smaller sizes designed for industrial or domestic-stoker use. It involves placing the various sizes in separate bins. The sizes may be as they naturally come from the sizing units, or they may be produced in part or entirely by preliminary crushing and rescreening facilities. Mixing normally is achieved by feeding the sizes onto a gathering belt ending in a boom section. The rate at which the sizes are fed out of the various bins establishes the percentages in the mix. This rate may be adjusted by adjusting gate openings, but is considered less accurate than special feeders that have been equipped with variable-speed drives.

Dustproofing

PURPOSE: Preventing the emission of objectionable volumes of airborne dust at the point of consumption by making dust and breakage resulting from handling and storing stick to the larger pieces.

The principal materials used for dustproofing coal are oil, calcium chloride and special chemical compounds, usually containing calcium chloride with other substances added. Calcium chloride and other chemicals and materials, including cornstarch and molasses, papermaking by-products and so on, pick up water from the air and thus provide a moist surface to which the dust adheres. Corrosion-inhibitors may be added to the chemical-type dustproofing agents to prevent possible attack of metal firing equipment and coal-handling parts.

Spray oils for dustproofing are available in a wide range of characteristics to fit the job being done. Equipment for applying them includes both heating equipment for spraying hot, and high-pressure atomizing, or "cold-oil" equipment for spraying cold. With the hot-oil systems, the oil-carrying lines may be paralleled by heating lines carrying steam or hot oil to keep the oil at the proper temperature at the point of application.

Quantity of material necessary to achieve a desired degree of dustproofing depends upon both the size and type of coal being treated. Since the treatment is a surface job, and

the surface to be treated increases as the size of the coal decreases, more material must be applied to the finer sizes. Porosity and other mechanical characteristics of the coal also influence both quantity and type of dustproofing material. With some very porous coals for example, good treatment with an economical quantity of petroleum-base material requires going to a very-high viscosity to prevent absorption of the material into the interior of the coal. Most of the high-volatile coals, however, may be treated satisfactorily with oils having a viscosity of around 200 deg.

Application—For maximum effectiveness with a minimum quantity of material, dustproofing material should be applied while the coal is in the air. Use of properly designed hoods prevents waste and insures maximum treating efficiency. Normally, such hoods are placed at the ends of loading booms or chutes, but they may also be placed over conveyors and other equipment, particularly those handling the larger sizes. The proper design of nozzle and the proper temperature at the point of application are key factors in the use of hot oil, and nozzle design is likewise important with other types of material to insure good treatment with minimum material quantities.

Regulation of material flow to the flow of coal may be accomplished by such steps as paddle-controlled valves at the ends of booms and chutes. The position of the valve is controlled by the thickness of the coal stream and in turn increases or decreases the flow of dustproofing material, preventing both overtreatment and undertreatment.

Freezeproofing

PURPOSE: Elimination of the labor trouble and adverse consumer reaction involved in the freezing of moist or wet coal in severe weather.

Where heat drying is not the practice and mechanical drying does not provide sufficient moisture reduction to prevent freezing, the coal may be treated with chemicals or oil. Such treatment usually is required with slack, screenings and other small sizes. The need for treatment is affected not only by the climate encountered but by industry custom and customer preference. Since anthracite, for example, has been shipped wet for many years and consumers have become accustomed to the situation and are prepared with the necessary thawing equipment, there has so far been little stress on freezeproofing in that industry.

Salt and calcium chloride, usually applied dry, are the two main chemicals used for freezeproofing. The quantity depends upon the expected temperature and the moistness of the coal. For calcium chloride, the Calcium Chloride Institute offers the following guide:

	Lb CaCl per Ton at Specified Temperatures, Deg. F		
Moisture	+32 to +15	+15 to 0	0 to −15
3%	3.0–4.5	4.5–6.0	6.0–7.5
6%	6.0–9.0	9.0–12.0	12.0–15.0
9%	9.0–13.5	13.5–18.0	18.0–22.5

Chemicals may be thrown into the car by hand or may be dispensed by mechanical feeders into the coal stream as it is loaded. The latter normally provides more uniform and more accurate treatment.

Oil is finding increasing application as a freezeproofing agent. One operation, as an example (*Coal Age*, February, 1956, p 75), uses an 80-sec oil at the following rates: ¼x0 centrifuged carbon, 6 qt per ton; 4x2 or 2x1¼ crushed to 1¼ or ⅞ in, 2 qt; 1¼x28M mix, 3.4 qt at a cost of 0.084c per ton. In loading coal under 1¼ in in size, the inside of every hopper is sprayed with 6 gal of oil for a 50-tonner and 7.6 gal for a 70-tonner at a cost of about 1c per ton.

Loading

PURPOSE: Economical placing of final product into car, truck or barge with a minimum of degradation and the lowest cost.

Anthracite is loaded into railroad cars almost entirely from storage pockets, reducing the number of loading tracks to one or two for many plants. Early bituminous practice was to provide a track for at least each major size, though a growing number of bituminous plants are providing pockets for certain sizes—usually stoker or other sizes in the smaller range. Loading of two cars on the same track is thereby possible by conveying one size to a pocket above or below the regular loading point.

Where only one size is produced, or where storage bins are provided for one or more additional sizes, loading of an entire shift's run of railroad equipment can be done with the elevated shuttle belt without moving a single car once they are set in by the railroad. One shuttle-belt installation (*Coal Age*, March, 1953, pp 94-95) is based on elevated narrow-gage track 760 ft long with a 380-ft-long 30-in reversible belt conveyor on wheels operating on it. The belt is between two tracks accommodating 20 cars each, and coal can be loaded either way at either end of the belt by pairs of discharge chutes and diverting gates. One man at a push-button station controls belt operation and the operation of the elevating conveyor feeding coal onto it from the preparation plant.

Booms have long been used to lower the coal into railroad cars with a minimum of breakage at bituminous plants, and there is a tendency to extend their use to the smaller sizes, particularly stoker, though the chute still is the popular loading device for slack, screenings and other smaller sizes. Belt, apron and scraper-type booms are employed, with shaker booms as an added starter. The first two lend themselves to hand picking on horizontal sections. The third can be equipped with degradation screens, the breakage being returned to the mixing conveyor or other point by the bottom strand.

Mechanical retarders provide positive control of car movement in loading, and there is a growing trend toward the use of motorized equipment, including special hoists which permit pulling a car back uphill if desired, or moving it back and forth several times to load the coal in layers.

Clean-Coal Storage

Stockpiling clean coal is a growing practice at bituminous mines, as well as anthracite. The favored place is on the ground, and the capacity ranges up to several thousand tons. With large stockpiles, belt equipment is used in almost all instances for both stocking and reclaiming, with the reclaiming unit usually placed in a subway under the stockpile. Piles may be single conical, laid down by a fixed-discharge conveyor; curved, laid down by a pivoting stacker conveyor; double conical, laid down by separate piling booms fed through a flygate, or by a reversible stacking belt; or long and narrow, laid down by a belt with traveling tripper. Lowering spirals or ladders are employed to reduce breakage where piling booms are not employed.

Truck Loading

Loading of trucks requires somewhat different practices. It is possible to load trucks over the tracks or by chutes brought out from the plant but this, among other things, makes it impossible to service trucks except when the plant is running. Consequently, the usual practice is to provide bins or pockets for sizes sold to

truckers. Spiral lowering chutes prevent breakage in filling bins holding the coarse sizes, and degradation in handling through the bins is removed by fixed screens in chutes, or by small shakers or vibrators.

Late truck-loading plants include, in the bituminous field, a multiple-silo installation in which the coal is distributed to the pockets by a pivoted elevated belt, which is swung on a curved track from one pocket to the other for filling purposes. Trucks are loaded through chutes.

In the anthracite field, a new six-bunker plant is designed so that all operations are conducted by two men and accurate dispensing of orders is controlled by presetting dials to control flight feeders delivering at rates up to 5 tpm (*Coal Age*, January, 1954, pp 68-69). The dials are calibrated to tenths of a ton and trimming to adjust weight is seldom necessary. Coal is delivered to the truck plant by two 24-in belts housed in corrugated pipe, and is distributed to the bunkers by two shuttle conveyors.

Barge Loading

Barge-loading plants fall into about five classes, as follows:

1. A simple dock from which trucks dump into the barge at times when water conditions permit.

2. The stationary chute type, which is simple and low priced and works well where river fluctuations are not too great and banks are steep.

3. Elevating-boom type, with barges moved back and forth in the river beneath. The elevating boom allows more loading time if river elevation changes greatly. This type is advantageous where the bank of the river is considerable distance from the channel and the elevating boom and conveyor belt can be combined for travel across the flood plain.

4. Floating barge type, with the loading boom mounted on a floating, or spar, barge and pivoted for easier loading. Requires a steep bank or fill to permit retraction and extension of the main conveyor with changes in water level.

5. The tripper-conveyor type, in which the barges are stationary and the loading chute moves back and forth to load and trim. Nothing has to be done to the barges but load them.

For examples of most of these types, see *Coal Age*, December, 1956, p. 58.

Tramp-Iron Removal—Removal of tramp iron is handled at a number of plants, even though all sizes are washed, by suspended magnets or magnetic pulleys at the point the raw coal enters the plant. If washing or removal in the raw-coal stage is not practiced, iron removal should be done in the loading stage, especially with coal designed for stoker use. Facilities include magnets designed for use in the bottoms of loading chutes, as well as other types of units.

Degradation Removal—See "Clean Coal Sizing."

Water Handling

PURPOSE: Economical handling to keep cost down and meet stream-pollution regulations.

Questions involved in water handling at plants cleaning by wet methods include:

1. Fresh water supply and treatment.
2. Clarification and recirculation.
3. Final disposal where circuits are or cannot be closed.

Makeup water requirements vary with the type of circuit. In a fully closed circuit, where sprinkling at the face results in an average of 5% surface moisture on the raw coal, which is the same as the average for the shipped coal, it can be seen that fresh water cannot be added. Normally, the only clear-water applications would be on pump glands and certain other essential applications. In an average plant, under these conditions, makeup water might well be only 50 to 75 gpm. In an open circuit, it might well be several times that minimum.

Sources of makeup water are:

1. Deep wells.
2. Surface water from lakes, ponds and streams, or from reservoirs made by dams to catch surface runoff.
3. Mine water, if available.

Watering from deep wells normally can be used without treatment. Mine water, on the other hand, may be quite acid, though there are exceptions. Surface water may or may not be acid, and may at times be contaminated by mud. Some authorities hold that the pH value of the water in the plant circuit should be between 8.0 and 8.5.

Other operators, however, feel that slight acidity is not objectionable. However, if the water is very acid, treatment with lime or soda ash is in order. Treatment permits plain steel for example, to be used instead of alloys, resulting in substantial savings in cost of equipment and materials, in replacement labor and in shutdown time. Even if the makeup is only mildly acid or neutral, acid may build up in the recirculated water and need treatment for that reason alone. Automatic equipment is now available for treating water efficiently and at minimum cost.

Unless there is an assured minimum flow adequate for plant need at all times, storage should be provided to tide the plant over periods of reduced flow. Impounding dams, if possible, and artificial ponds and storage tanks are among the answers. In hilly country where dams are not feasible, wood-stave or other tanks are employed by some operators to store up to, say, ½ million gallon.

Handling Wash Water

Stream-pollution regulations and the need, in many instances, for decreasing the loss of good coal to the refuse have resulted in major activity in the processing of wash water. A third reason for processing is to prevent the buildup of solids in water recirculated to washing units, since excessive buildup may materially affect the gravity of separation and consequently cleaning results. Available data indicate that many preparation men regard a solids content of more than 15 to 20% as excessive, while some try to keep it under as low as 5%.

Closed circuits frequently are mentioned as objectives in water handling—and are practicable in some instances though not in all. Reasons for circuit closing include: (1) elimination of discharge to streams, (2) reducing makeup water to that required for pump glands and other essential uses, (3) recovery of coal and (4) recovery of medium (see p. 141). As a corollary of closing, however, it is necessary to remove at least part of the solids, especially if clay and mud are present, to prevent solids buildup and a change in the gravity of the cleaning bath.

Closing a circuit may either be impossible or not desirable, however. If, as previously indicated, moisture on the coal leaving the plant is equal to that entering the plant, the quantity of makeup water that can be added without bleeding is nil. Thus, even gland-water requirements, if included in the water circuit, can force bleed under some circumstances.

Practice and field custom also may result in bleeding of some to considerable quantities of wash water. It may, as an example, contain large quantities of high-impurity fines that would be difficult to clean even if recovered, and bleeding to ponds, if space is available, might be the most economical disposal system. And under some conditions, it may be necessary to feed excess fresh water into the system for essential services, even

if it is not required to rinse off clean coal and improve appearance as it might be in some instances.

Also, complete closing in the sense of allowing no escape of either coal or water may become impossible if certain steps are considered desirable in the preparation process—for example, desliming at 325M. The slimes must go somewhere and it is not always practicable to prepare them so they can be put in with the clean coal or the refuse.

Since bleed therefore becomes necessary in the majority of instances, the sludge pond also becomes necessary and takes its place as an item in plant facilities. Examples of its use include the following:

1. Effluent containing minus 100M flowed to 7-acre pond for solids settlement and subsequent reclamation by dredge and flotation; clear water returned for plant use because natural supply is not always sufficient.

2. Settling pond used to clarify waste water for water reclamation and to conform to antipollution regulations; recirculating water clarified in 125-ft thickener.

3. Preliminary clarification with settling tanks and large and small cyclones done primarily for coal recovery; some 98% of the minus 200M material bled off to pond to keep solids content of the system constant.

4. Vibrating screens followed by settling pond prevents clay buildup and enables plant to comply with anti-pollution regulations.

5. Settling ponds used to keep solids content of circulating water under 15% at plant using thickener, cyclones and vacuum filters. This is achieved by bleeding system when solids buildup requires it. Average solids content of bleed water is 17 to 20%.

Solids Reduction—The goal in this operation, in contrast to fairly complete removal to meet pollution regulations, for example, is keeping the solids content of recirculated water to a reasonable figure: not over, say, 15 to 20%. The old-reliable conical or drag-conveyor settling tanks are standard equipment units for this purpose.

Examples of how sludge ponds may be used for this purpose are summarized in the preceding section. Other systems and equipment include the following example:

Settling tanks to accomplish primary recovery of coal, with overflow to two batteries of large and small cyclones. Small cyclone overflow returned to system but part containing 98% minus 200M is bled off to keep solids content of system down to 10%. Underflow from both cyclones goes to vacuum disk filter for solids recovery prior to heat drying.

Flocculation—Where natural settlement is depended upon for removing solids from wash water, results reflect the size of the material, the time provided for settlement, and the degree to which disturbance can be reduced. Flocculation of the material promotes settlement, and some types of thickeners are built to permit flocculation along the settlement.

Solids Removal—Complete removal of solids may be desirable for two reasons: (1) salvage of good coal from the wash water, or (2) conformity with pollution regulations. Where coal is concerned, the same installation ordinarily accomplishes both results. Where refuse is involved, the only goal is meeting stream-pollution regulations.

Settling ponds, where space is available, are perhaps the simplest method of attaining sufficient solids removal to conform to pollution regulations. In some instances, they may be the cheapest, though not always. Their construction involves some expense, and if the capacity is limited they must be cleaned out from time to time. With ponds also, any fines that reach them, if of good quality, are either lost or can be recovered only at some added expense. Consequently, there is a trend toward extracting at least part if not all of the solids from the water before running it to the pond.

Equipment for accomplishing some solids removal before discharge to the pond may be merely the old reliable conical or drag-conveyor settling tank. Other units are thickeners, hydraulic or nonhydraulic classifiers, cyclones, and filters of various types. Combinations of equipment to keep the final discharge to the pond as low in solids as possible, and consequently keep pond size to a minimum while at the same time lengthening its life to the maximum include, at one operation, a cyclone installation (*Coal Age*, December, 1954, p 62), followed by a vibrating screen to receive the underflow—dewatering it and discharging it to refuse or clean coal. The screen underflow may be recycled to the cyclones, while the cyclone underflow, containing minus 200M, goes to the pond. The 200M, however, stays in suspension longer, and to reduce the possibility of an overflow containing a heavy percentage of such material, flocculation may be the answer.

A drag tank, a thickener and a disk filter are used at another property to remove all but the minus 300M from water containing minus 60M.

Filter Circuits—Three variations in a solids-removal flowsheet involving flocculation and complete closing of the circuit (*Coal Age*, January, 1955, p 76) are shown in an accompanying illustration. The goals are economical operation and removal of the solids so that they can be handled the same as any other solids, whether coal or refuse. Variation A is recommended where the fine-coal circuit includes a gravity classifier effectively classifying at 30 microns; Variation B, where gravity classification is such that an appreciable quantity of plus 30-micron material is found in the overflow; and Variation C, where the equivalent of two-stage cyclone concentration is employed.

Three water-handling systems based on filters for final recovery of the solids also are shown in the accompanying illustrations. Suggested for use where clay slimes are not excessive and closed-circuit operation can be obtained by filtration, or where the large slime fraction is bled off to a sludge pond, the three systems involve:

1. Cyclone classifiers in conjunction with gravity classifier or thickener delivering thickened underflow for filtration.

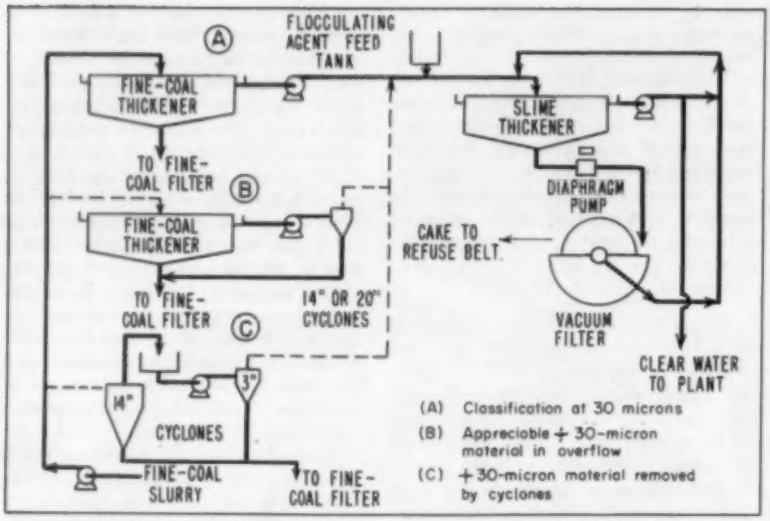
2. Cyclone classifiers in conjunction with filters. The two-stage system shown may be employed (1) where solids under 100M are too high in ash to be included in clean coal and (2) all underflows from both stages are filtered as clean coal. A buildup of minus 100M in the circulating water is prevented in both instances.

3. Thickeners and cyclones for preliminary concentration. Better filter operation is one of the advantages.

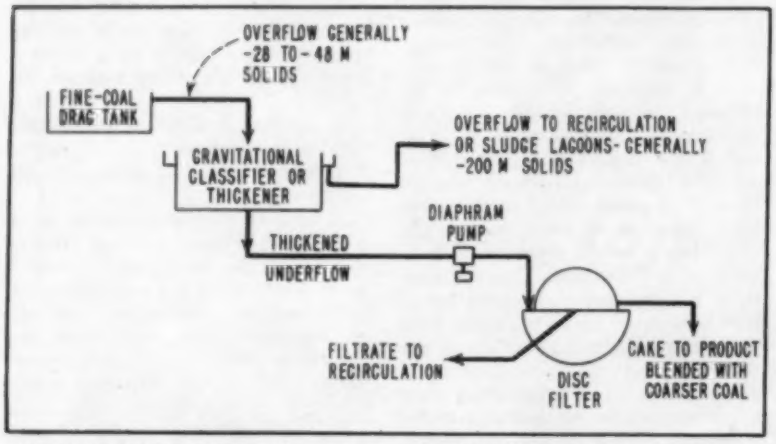
In any of these three systems, the underflow from the drag tanks may be dewatered in any one of a number of ways separately from the overflow. Among the equipment that may be used is screens, and basket-screen or solid-bowl centrifuges.

A fourth illustration is another example of how a system may be set up (Jerry Apotheker, D. A. Dahlstrom, AIME, 1955). It uses settling tanks for both the raw and the clean coal, with centrifuging of the clean-coal underflow before final dewatering in a flash dryer. The filter cake is shown going to refuse but if it was of good quality it could be fed back to the clean coal. Solids in the circulating water are stabilized at about 10% and provision is made for overflow bleed in case of buildup. The filter also recovers dust from the flash-dryer exhaust.

Water Circulation—Head tanks with automatically controlled pumps



SOLIDS REMOVAL from wash water by flocculation and filtration.


OVERFLOW GENERALLY -28 TO -48 M SOLIDS
FINE-COAL DRAG TANK
GRAVITATIONAL CLASSIFIER OR THICKENER
OVERFLOW TO RECIRCULATION OR SLUDGE LAGOONS- GENERALLY -200 M SOLIDS
DIAPHRAM PUMP
THICKENED UNDERFLOW
FILTRATE TO RECIRCULATION
DISC FILTER
CAKE TO PRODUCT BLENDED WITH COARSER COAL

VACUUM FILTRATION with gravity classifiers or thickeners for preliminary classification of the feed to the unit.

provide a uniform head on washing equipment, with consequent increase in the efficiency of separation, particularly with jigs. Provisions for coping with water and solids include the proper types of metals or the proper linings in pumps, as well as plastic, rubber and other special forms of pipe for certain applications to resist both wear and corrosion. Rubber-pinch and orifice-type valves solve some of the flow-control problems and provide good regulation, in addition to reducing the valve maintenance problem.

Handling of casual and spillage water is simplified by proper design of the basement floor, which should be equipped with drains leading either to the pond or to a recirculating-water sump. Cleaning up by washing down is facilitated by such construction, and, as indicated, the coal may be returned for re-processing.

Sludge Recovery

PURPOSES:

1. **Water clarification.**
2. **Recovery of saleable material.**

Normally water clarification and the recovery of fine coal, whether called sludge, slurry or some other name, go hand in hand, although if clarification only is the goal, the material may only be routed to the refuse bank, particularly if it is refuse in fact. However, the percentage of material finer than, say, 10 or 28M, may be substantial at many plants and may warrant recovery for its own sake, especially if it can be shipped without further processing. Even where processing is required, the quantity and character of the fines may warrant a substantial investment, particularly if clarification also is required or is desirable for any reason.

The equipment for recovering sludge from wash water, as noted in the preceding section, includes: settling cones and tanks, and thickeners and filters, along with hydraulic and nonhydraulic classifiers and cyclones. cleaning equipment includes flotation units and special fine-coal washers, followed by normal dewatering and drying.

The preceding envisions recovery of the sludge as it is produced in the plant. Another form is recovery from old silt or sludge ponds or banks. Recovery equipment includes conventional shovels and also floating dredges. At some installations, the final step consists of drying. A modification, where the nature of the material warrants, is centrifuging to throw out the fine impurities and then heat drying. Where cleaning is considered desirable, a number of large plants have been built for conducting this operation by froth flotation, which may be followed by drying of the desired type.

Refuse Disposal

PURPOSE: Final disposition of the refuse at a minimum cost and so that it will not result in a nuisance to neighbors.

The dump truck has taken over a large part of the refuse-disposal job in the coal industry today. Its advocates cite low cost and maximum flexibility, especially where it does not have to surmount too-heavy grades. The aerial tramway lends itself not only to disposal in what might be called normal territory but also to taking refuse across hills into neighboring valleys and the like. The side-dumping or revolving larry, in addition to ordinary situations, also is used to build out from hilltops or hillsides from bins fed by belt conveyors, tramways and the like.

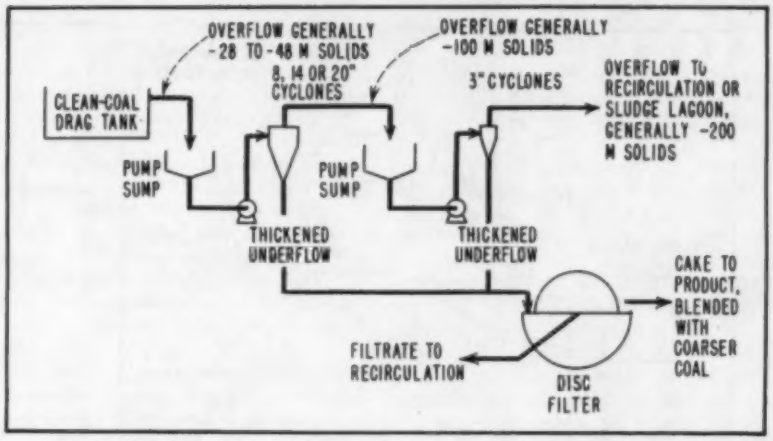
Pumping of refuse is growing, though the question of taking care of the water to prevent stream pollution comes in. In some instances, it has been possible to pump into old mines or worked-out sections. The pumps will handle rather large pieces but normally pumping requires crushing to a top size of 2 or 3 in. Even with other methods of disposal, especially where large mine rock is handled, it may be economical to crush with rock-type equipment, such as jaw or gyratory crushers. Easier handling, a more-compact pile and greater ease in maintaining a running surface where trucks are used are among the argu-

ments in favor of crushing not only mine rock but also large refuse of any nature.

Where refuse output is large, and especially where trucks and similar equipment are employed, a bulldozer for spreading and compacting may pay off. Properly equipped, the bulldozer also may be used to shift track where larries are employed. A few refuse trucks themselves have been fitted with front blades or with special tailgates for spreading, particularly if the material handled tends toward the small side.

Prevention of firing of refuse dumps has been the subject of considerable research in recent years, and the spread of automotive haulage has made possible new and effective methods of piling, compacting and sealing refuse to practically eliminate firing. One method of layering, compacting and sealing against air is described in *Coal Age*, June, 1951, p 91. Development of the method also was accompanied by steps to extinguish an old fire by stepping, trenching and filling and covering with earth as conditions dictated.

Under some circumstances, the disposal problem may be solved by converting refuse into a lightweight aggregate and selling it. Requisites are refuse of the proper type and a market within practicable shipping distance. One plant of this type is described in an article in the November, 1955, issue of *Coal Age*, p 78.


OVERFLOW GENERALLY -28 TO -48 M SOLIDS
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8, 14 OR 20" CYCLONES
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OVERFLOW TO RECIRCULATION OR SLUDGE LAGOON, GENERALLY -200 M SOLIDS
CLEAN-COAL DRAG TANK
PUMP SUMP
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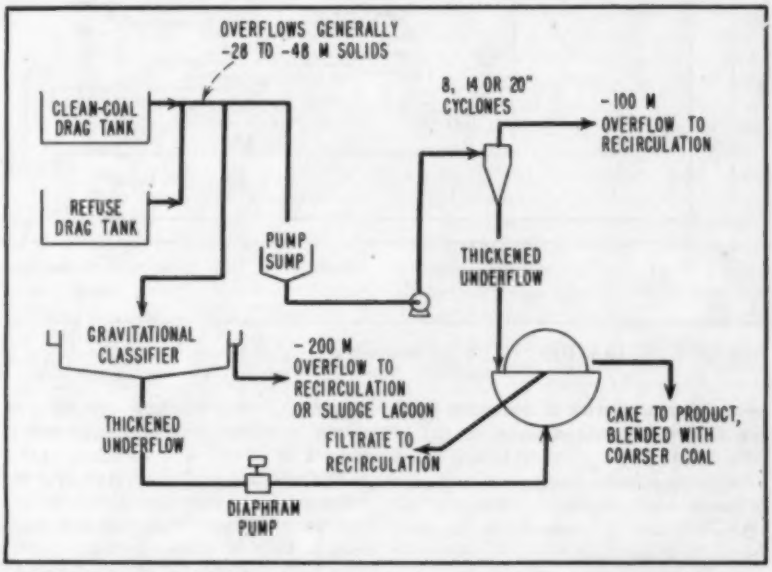
FILTRATE TO RECIRCULATION
DISC FILTER

VACUUM FILTRATION with cyclones for preliminary classification.



VACUUM FILTRATION with gravity thickeners and cyclones for preliminary classification of the feed before filtration.

Power

PURPOSE: Adequate capacity and voltage with a minimum of maintenance.

Voltage—Accepted voltage for most of the stationary motors in preparation plants is 440, leaving in most instances only the question of whether 2,300 v should be used for certain large units, such as pumps, crushers and the like. A rough rule is that motors of 100 hp and larger should be 2,300.

Transformer Location – Packaged substations with oil-filled transformers are available for outdoor service, with nonflammable units for indoor. Outside is the place for the transformer station if the highline voltage is over 10,000 and the reduction to 440 is made in one step. If the supply voltage is less than 10,000, the packaged indoor substation with nonflammable transformers is the general choice, principally because it can be placed closer to the center of the load.

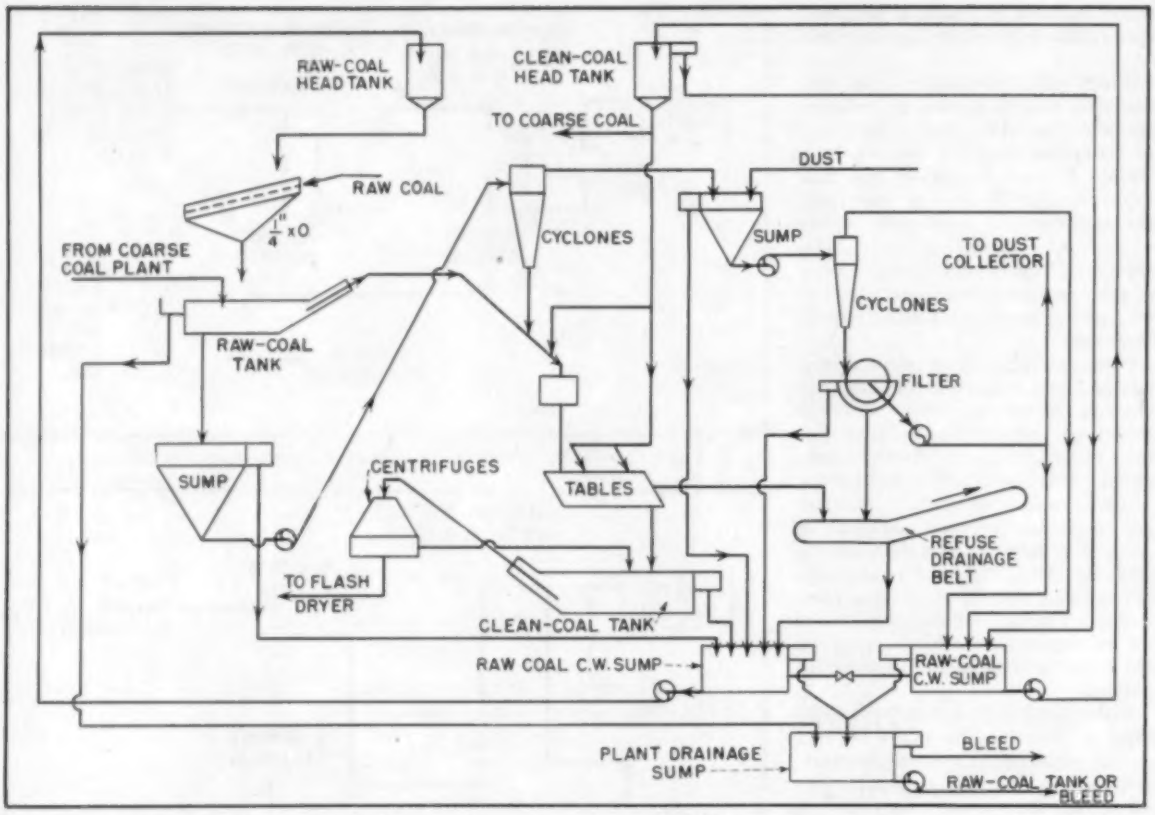
Controls—Starters grouped in factory-assembled control cabinets are now standard for preparation plants. One central cabinet is satisfactory for a small plant, but a large plant may require cabinets at several locations to keep the motors reasonably close to the starters. Draw-type starters which can be pulled out for quick replacement are coming more and more into favor.

Dust is one of the major problems in location and operation of starting equipment. The best solution seems to be one or as few control rooms as possible made fairly airtight and fitted with blowers to maintain a slight positive pressure inside the rooms. Air forced into the rooms should be filtered. The combined effect will be cleaner air in the control room.

Capacitors – The induction-motor load of the preparation plant produces a low power factor, which adds to the bill and heats conductors and motors. Capacitors should be installed in the plant to bring the lagging power factor up to unity. Theoretically, an appropriate capacitor should be placed at each motor. However, practical limitations of cost, space and maintenance generally make it advisable to group the capacitors in the control room.

Maintenance

PURPOSE: Efficient plant operation with no or a minimum of interruptions. A collateral goal is conduct



VACUUM FILTRATION SETUP for final dewatering of refuse fraction, including raw- and clean-coal drag tanks, cyclones for classification, tables for cleaning, and centrifuges ahead of the heat dryer.

of maintenance with a minimum cost for labor and materials.

Maintenance is necessary because of wear and corrosion inevitable in operation, and the effects of the elements, for example:

1. Rusting of the exterior and interior, including structural members and equipment, as a result of rain, snow and water.

2. Corrosion from acid water and, on occasion, from the gases given off by burning refuse dumps. Acid-water corrosion, of course, shows up most in washers, screens, tanks and other facilities exposed to water.

3. The effects of heat and gases involved in heat drying.

4. Wear from the handling of coal and rock.

5. Lack of lubrication, overloading and other abuse, faulty electrical service and the like, resulting in motor and machine breakdown.

Maintenance Factors

All wear and corrosion, cannot, of course, be eliminated. However, consideration of the causes and their effects logically indicate the remedies which, in large part, are preventive in nature. In other words, use of the proper materials and proper designs when a plant is built, or when parts or sections are added or replaced in existing plants, are major factors in maintenance cost. These materials and designs include the following:

1. Location of heavy equipment, particularly of the rotating or reciprocating type, on or as near ground level as possible: cuts structural cost and reduces the effects of weight, motion and vibration.

2. Bracing, steel weight, balancing and damping to provide stiffness, reduce or eliminate unbalanced forces, and prevent the transmission of motion and vibration to the structure.

3. Use of protected steel and special roofing and siding materials, including asbestos-cement and aluminum.

4. Protective coatings and paints for steel exposed to rain, moisture, gases and the like. Paints and coatings normally, of course, are not for surfaces exposed to moving coal or rock, water carrying solids and the like.

5. Neutralization of acid water with lime or soda ash. Automatic feeding equipment now available facilitates this job. Frequently, neutralization will make it possible to get much-longer life from ordinary steel, saving both in material cost and replacement labor.

6. Use of corrosion- and abrasion-resisting materials for screens, chutes, flumes, water lines, pumps and so on, including plastic, rubber and asbestos-cement water lines and connections, and rubber-pinch and orifice-type valves. Stainless steel for bolts, for example, can solve some annoying corrosion problems in certain preparation applications.

7. Use of linings to resist wear and, with some types, corrosion. Examples include glass, tile and brick in chutes; and rubber, plastic, sand-cement and ceramic linings for tanks and cones. Entire loading pockets have, on occasion, been built of glazed tile to combat wear and corrosion. Another form of lining is special hard metal for conveyor bottoms. Hard-surfacing of wear points or the use of special wearing strips are natural accompaniments of the broad use of lining materials.

8. Use of totally enclosed, splash-proof and other special motors for dusty, wet and similar locations, plus moisture- and dustproof controls or the location of controls in rooms with blowers using filtered air and main-

taining a slight positive pressure inside the rooms at all times.

9. Good lubrication with proper equipment and quality lubricants of the correct types applied at the correct intervals. Centralized automatic systems are growing in favor as a result of demonstrated benefits, and have proved their ability to handle even such difficult problems as underwater bearings in settling tanks.

10. Regular inspection and cleaning of preparation equipment. Cleanliness and good housekeeping for the plant as a whole naturally supplement these, and to facilitate housekeeping a growing number of plants are being equipped with hoods and covers for certain equipment connected to exhausting and dust-collecting equipment, plus vacuum systems for cleanup.

Quality Control

PURPOSES:

1. Attainment of the desired preparation standards with a minimum of deviations and a maximum of efficiency.

2. Securing data on the quality of shipments for possible use in adjusting complaints and as a final check on preparation performance.

Control of preparation results starts, as indicated in earlier sections of this Guidebook, by such steps as blending, proper picking practices, uniform feed to cleaning units, proper adjustment of cleaning equipment, and so on. Checking on the results and getting records on shipments, the subject of this section, is largely a means of making sure that all the other steps are being carried out properly.

Checking and control measures are both visual and mechanical or chemical. With lump, for example, the bulk and weight of a proper sample, and the increased difficulty of getting a representative sample, make mechanical and chemical tests difficult, and reliance must be placed largely on visual inspection. In washing, visual inspection—by operators who know their business—of the feed and draw material can reveal changes in condition immediately and permit adjustments to be made promptly, although this type of checking is subject to the normal human frailties.

Even with mechanical and chemical methods, the change in conditions takes place before the results are available, thus re-emphasizing the importance of adjusting operating conditions to provide the desired results as nearly automatically as possible. However, even though the data are obtained after the fact, mechanical and chemical tests are necessary to provide positive evidence of whether or not the desired results are being attained and permit adjustment if not.

Sampling—Where the tonnage is at all large and a careful check on quality is essential, one or more specialists should be charged with the responsibility of collecting samples. Depending upon the control setup, they also may run sink-and-float tests and prepare samples for more-elaborate chemical tests.

Number of samples and sampling intervals depend upon control and quality data required. Egg and lump —and perhaps nut and pea—may be sampled at longer intervals and perhaps only once a shift or longer. The problem grows more critical with the smaller sizes, especially where sales are made on a specification basis. As a result, many plants sample stoker and screenings, as examples, at intervals of as small as 15 min, while every hour is fairly common.

Automatic samplers installed at transfer points, especially for the smaller sizes, reduce the labor involved in sampling and tend to increase the accuracy. Manual methods include the car sample taken at a number of spots, but the trend today is toward cutting samples out of the coal as it flows into the car. A convenient method is to mount a narrow box of the requisite length and depth on a pivoted arm which is swung through the coal stream at the specified intervals. Labor is saved and the sample tends to be more representative.

If the sample is intended for chemical analysis in the laboratory, time and labor can be saved by placing the preliminary sample-preparation equipment—crusher, splitter and the like—at or near the point the sample or samples are taken. As an example, some plants have provided platforms alongside the loading booms for sample preparation. Among other things, this permits running the coal left over after splitting directly to the car.

Test Procedure—Samples for checking cleaner operation normally are processed by sink-and-float. The equipment, which includes factory-made units designed specifically for the job, may be on the cleaning floor or at some other convenient location in the plant. The weight of the sink in a standard sample of cleaned coal is a working indication of how the cleaner is performing. The results also may be converted into fairly accurate ash figures by reference to a curve based on the average results of analysis of a representative number of samples, provided testing is carefully done and the character of the refuse is not subject to sharp fluctuations.

Checking the efficiency of washer operation also requires testing of refuse to make sure that coal loss is not excessive, and also of the raw feed to determine whether a change in its character will establish different limits on the results that may be expected or will necessitate readjustment to attain the original standards.

More precise results of course can normally be expected by laboratory procedure, although the time interval necessarily is longer. Equally or more important, the laboratory is the only means of attaining all the chemical and physical data on both processing results and the character of the shipped coal, including ash, sulphur, moisture, heat content, fusion and softening temperatures of ash, and so on. Also, the presence of laboratory facilities permits research into suggested changes in preparation procedures and forecasting of results. Therefore, more and more plants are being supplemented by well-equipped laboratories. An example is the subject of an article in the April, 1950, issue of *Coal Age*, p 90.

Laboratories normally are placed in separate structures although a few have been built in the preparation plants themselves. The added convenience is said to more than compensate for the necessity of careful enclosure to keep out dust and noise, and the cost of methods of insulating the laboratory from vibration and motion.

Sizing Control—Since the accuracy of screening can have a major effect not only on realization but also on customer acceptance, quality control must take in size checking also. Facilities will vary with the circumstances at the individual plants but they should at least include a test-screen unit, which may be purchased from various manufacturers.

Records—The type of records kept for operating and quality-control purposes should provide for putting down the data obtained in a form that will make it easily available to and usable by operators, supervisors and other interested persons. Graphic presentation by curves may be a part of the record system, and the data to be entered may include such things as valve settings on washers. For shipments, the record may show car number, size, ash, sulphur, heat content, moisture and so on.

The Maintenance Guidebook

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MAINTENANCE has taken on a new look in coal mining today. It is no longer considered a necessary evil. This change was brought about as a direct result of increasing wage rates, the rising use of machinery to offset these increases, and the change to the day-rate method payment, which increases the cost penalties suffered by the company when production is interrupted. Repairing a machine after trouble occurs is the least desirable of the three major objectives in maintenance, which are:

1. Preventive maintenance, which might be termed "productive" maintenance, since production and cost depend upon keeping the machine running at full capacity as much of the time as possible is the key to all maintenance systems.

2. Improvement in machine condition, if possible, or at least preservation of original machine condition and capacity during its useful life, which life, on this basis, is determined by obsolescence rather than wear.

3. Repair of equipment after breakdown.

Prevention of machine breakdowns, or "production" maintenance, quite properly holds first place in organizing maintenance. The importance of this principle becomes apparent with a little study of breakdown cost. A loss of an hour's time, for example, can mean a wage outlay with a 10-man crew, of approximately $25 for which no production is received. Or, looking at it another way, if the unit averages a ton a minute, an hour's delay would mean a loss of 60 tons, increasing the section labor cost per shift, depending upon travel time, 8 to 10¢ per ton in this instance.

The "chain-reaction" principle also has become more and more a factor in maintenance thinking as machines have taken over more of the production load, as more and more productive capacity has been concentrated in individual units, and as the day-rate method of wage payment has become almost universal. Thus, for example, a fall on a loading station or a slide in a strip pit hurts much more now because of this concentration of production and because a much-greater part of the money outlay continues while production is at a standstill.

Trend Markers—Maintenance

"Preventive" maintenance is being emphasized as a result of increased use of more complicated and costlier equipment, and to obtain lower production cost.

Maintenance budgets increasing accordingly and will assume an even larger share of coal cost.

More money will be spent on training than ever before as a result of a shortage of qualified maintenance personnel.

Case-Finder—Maintenance

Productive Maintenance—Complete equipment data, evaluation of critical and routine maintenance, development of methods for critical and routine maintenance. *Coal Age*, September, 1956, p 68.

Maintenance Training for Supervisors—How training starts, what is taught and what the gains are. *Coal Age*, September, 1955, p 68.

Improvement Through Training—Program for mechanics and electricians involves 3-hr classes twice a week for a minimum of 48 hr of instruction and practical exercises in electrical theory and trouble-shooting. *Coal Age*, April, 1957, p 76.

Getting More from Portable Cables—How machine design and cable construction, plus proper application and care in use, contribute to reliability, service and minimum cost for electric cables. *Coal Age*, February, 1956, p 94.

Automatic Lubrication—How centralized systems are applied and how to save in lubricants, lubricating delays and in parts by accurate, automatic lubrication in accordance with use. *Coal Age*, August, 1955, p 60.

New Hydraulic Fluids—Equipment using hydraulic fluids, estimated annual consumption, possible synthetic fluids to reduce fire hazards. *Coal Age*, January, 1957, p 82.

Metallizing in Maintenance—Where it can be used, what it does and how it saves. *Coal Age*, March, 1955, p 84.

Getting Efficient Maintenance

Nothing being perfect, breakdowns and production interruptions cannot be completely eliminated, but they can be kept to a minimum by a reasonable expenditure of time and money. As an example, a month's report on six continuous miners working two shifts a day at one operation where tons per man average for the units ranged from 41.0 to 57.3 showed a breakdown total of 150 hr

FOREMANS TROUBLE REPORT FORM FOR MECHANICS

To be filled in by Foreman---

SECTION NUMBERS: _____ SHIFT: _____ DATE: _____ FOREMAN: _____

TIME TROUBLE NOTED:	_____	AM	_____	PM
TIME CALLED MECHANIC:	_____	AM	_____	PM
TIME MECHANIC REPORTED TO SECTION:	_____	AM	_____	PM
TIME MECHANIC COMPLETED JOB:	_____	AM	_____	PM
TIME MECHANIC LEFT SECTION:	_____	AM	_____	PM

FOREMANS DIAGNOSIS OF TROUBLE:

EQUIPMENT DESCRIPTION: Type: _____ Ser No.: _____

To be filled in by Mechanic---

MECHANICS SIGNATURE: _____

ACTUAL WORK PERFORMED BY MECHANIC:

_____

WAS JOB COMPLETED TO STANDARD? ____ IF NO, STATE REASON WHY AND EXPLAIN WHAT'S REQUIRED:

IMMEDIATELY AFTER MECHANIC HAS COMPLETED JOB HE WILL TURN THIS WORK ORDER OVER TO THE FOREMAN THAT MADE REQUEST. THEN MECHANIC WILL REPORT TO HIS REGULARLY ASSIGNED DUTIES.

NOTE: TO FOREMAN: If above job was not completed to standard the oncoming mechanic must be notified by the above reporting foreman.
This work order to be forwarded to the maintenance superintendent.

CONFIRMING WORK SHEET

MINE: _____ UNIT NO: _____ DEPT. NO: _____ DATE: _____ SHIFT: _____

EQUIPMENT DESCRIPTION: _____ TYPE: _____ MODEL: _____ SER. NO: _____

Description of work done this shift

NOTE: Attach copy of order for supplies to this report

TIME REQUIRED TO DO JOB: From Time: _____ M to Time: _____ M Date: _____

List of Materials used this shift

Quantity	Part No:	Part Description:	New	Old	Price	Total

Equipment Description: _____ Serial Number: _____

Mine: _____ Section: _____ For Month of: _____ 19__

M = MECHANICAL DELAY E = ELECTRICAL DELAY C = CABLE SPLICE

Record of Delays							Production			Cost
				Total Delay in Minutes						
Date	Delay Explanation:	From Time	To Time	M	E	C	Tons Loaded	Tons Hauled	Places Cut	Daily Supply Cost

FOUNDATION OF ANY MAINTENANCE SYSTEM is good reports and records.

Mine No.....

Repairman's Weekly Inspection Report

Loader No. ..... Date ..... Location .....

MOTOR

Brushes and Commutator .....
Holders, Springs and Leads .....
Armature Bearings, Grease .....

CONTROLLER

Fingers and Tension .....
Segments and Cylinder .....
Wiring .....

CIRCUIT BREAKER

Contacts .....
Tripping .....

HYDRAULIC SYSTEM

Control Valve .....
Four Way Valve .....
Pressure Pump .....
Hoses and Connections .....
.....
Fwd. and Reverse Leathers .....
Front Jack Leathers .....
Rear Jack Leathers .....
Swing Cycl. Leathers .....

CLUTCHES

Front Clutch ..... Slipping Amperes .....
Rear Clutch ..... Slipping Amperes .....

CONVEYORS

Rear Chain Tension .....
Front Chain Tension .....
Compound Chain ..... Grease .....
Flights Rear Conveyor .....
Flights Front Conveyor .....

GATHERING HEAD

Seal Packing Rings .....
Grease ..... Dirt .....
Gathering Arms ..... Bolts ..... Bits .....

TRANSMISSION CASES

Grease ..... Leaks .....

CRAWLER DRIVE

Chain Tension ..... Grease .....

SWING ROPES

Ropes and Clamps ..... Sheaves .....
Remarks .....
.....
Coal Drill Inspected .....
Cutting Machine Inspected .....
Repairman ..... Ck. No .....
Helper ..... Ck. No .....
Total Hours .....

INSPECTION REPORTS help by uncovering conditions which might result in breakdown if not attended to in time.

29 min out of a total of 1,848 possible producing hours, or 8.2%.

Reports and Records

Make certain that reports and records provide necessary information on the causes of delays and time lost.

Concentrate maintenance where the greatest gains can be made by using information received from detailed reports.

Have equipment inspected in detail at regular intervals.

Keep cost records of repair parts and labor for each unit.

Route summaries of reports and records weekly or monthly to responsible operating or maintenance heads.

MAINTENANCE PROGRESS cannot be made effectively without proper reports and records. Even though paper work is involved, careful study of the types and numbers of forms will reduce it to a minimum—and will make that minimum more valuable.

Types of Reports and Records

Daily Delay or Operating Report—In breakdown prevention—the No. 1 goal i.. maintenance—the daily delay or operating report is a must. It shows what the mechanical and electrical failures were and how much time was lost with each. Also, these reports may be expanded to show other delays and their causes to permit appropriate action. Thus, they become running time studies of machine performance, and provide invaluable data for eliminating the causes of reduced efficiency.

The daily report may be rather simple, per the accompanying example, which concentrates on production and delays only. Or, as in the second example illustrated, it may include details on labor, parts used and a description of work done. In this particular example, both mechanic and foreman fill in part of the report of each delay.

Periodic maintenance reports and daily lubrication charts, as illustrated in the accompanying examples, furnish check blocks as various parts are lubricated and also list duties and responsibilities of greasers. Another example shows periodic maintenance reports including parts to be inspected and on what type of equipment.

Automatic records of operating and delay time are possible on certain types of equipment. Examples are swing recorders for shovels and draglines, and electric clocks hooked up with feeders in preparation plants so that they run only when the feeders run. Such equipment eliminates human errors in computing or entering lost time and, in the case of the feeder clock, permits checking on how the plant is doing at any time merely by a glance. Swing charts, on the other hand, permit detailed study of what has been happening if it should appear necessary.

Work-Needed Report—To attain fully the goal of preventing breakdowns, some form of reporting on work or adjustments is a necessity. It permits reporting a part that seems likely to fail so that the necessary steps may be taken to repair or replace it on the next idle shift.

Work needed may be reported either on the front or back of the regular delay form, or it may be reported on a special form. Where it is entered on the regular form, special handling may be necessary to make sure that both the repair foreman and the superintendent, for example, get the data they need without delay. Or, the forms may be made out in duplicate or triplicate and routed accordingly.

Where separate forms are used, the original naturally goes to the repair foreman, with perhaps a copy to the superintendent. In some instances, the form includes space for reporting on when the work needed was done, with or without copy to the superintendent, as a further means of insuring that prompt action is taken.

Inspection Report—As a second means of preventing breakdowns, a number of mining operations have instituted inspection reports. An example is illustrated elsewhere in this section. The frequency of such reports can vary from daily to monthly or longer, with a week or a month as the most common. The reports are derived from special inspections of a varying degree of thoroughness, and normally involve going into certain

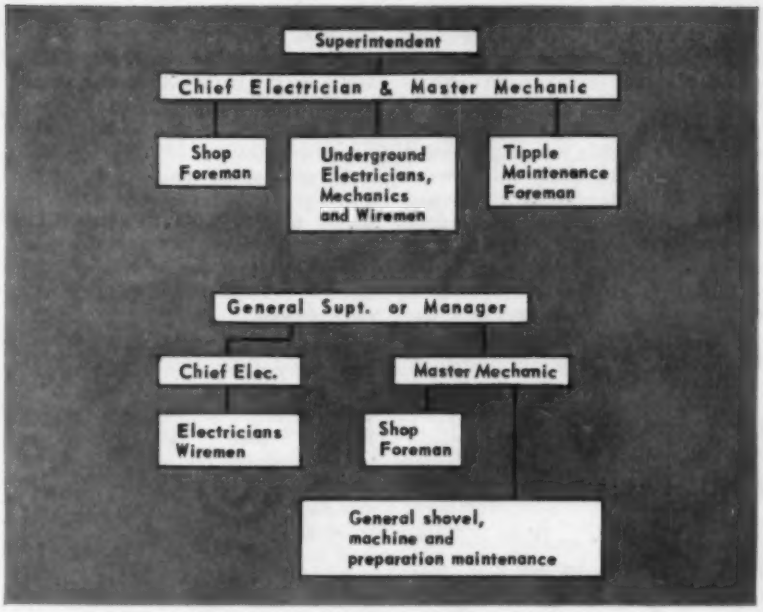
cases and the like. In other words, the machine is given a more thorough examination than would normally be involved in a quick daily once-over. Inspections may be made by the regular section electricians or mechanics, or by special men from the mine or central shop. These men at the same time can make certain adjustments and repairs, and can note larger jobs that may require taking the unit out of service.

A recent newcomer to mine maintenance personnel is the electrical-mechanical inspector. His primary duties are to conduct and plan inspection schedules for all equipment, make out equipment reports and submit them to responsible operating and maintenance heads, to make sure that work orders are carried out and completed as scheduled, and to recommend when certain equipment should be taken out of service for overhaul.

Unit Cost Record—There is a growing trend toward keeping a complete record of repair parts and labor unit by unit. Labor in this instance normally means special labor beyond the usual attention given by the section mechanic—in other words, shop and special labor required for major repairs and overhauls. Paper work is increased but the accurate unit record provides, among others, these advantages:

1. Excessive expenditures may signal waste or loss of parts sent into the section for running repairs, as well as lack of lubrication, abuse of the machine by operators, and so on.
2. Rising expenditures may signal the need for overhaul earlier than normally scheduled to prevent excessive machine breakdowns.
3. Consistently higher expenditures for one type of machine, compared to another of equal capacity, may make it desirable to standardize on the lower-maintenance unit, other things being equal.
4. Data on the value of special materials—for example, stainless steel—can be readily obtained to show if they are worthwhile or not.

For maximum convenience, unit cost records may be kept on cards designed for rotary or other quick-viewing files. The data for the records naturally comes from requisitions for parts and materials submitted by the foremen or other responsible officials, and from reports on parts used and labor expended by the repair foreman. Naturally, also, summaries of the unit records should be made at regular intervals—perhaps monthly—for the superintendent and other officials having jurisdiction.



SHARED RESPONSIBILITY between operating and maintenance departments facilitates efficient maintenance.

Record Distribution—As implied in the preceding paragraph, reports and records can be fully effective only when they, or the data from them, are regularly routed to the responsible operating or maintenance heads.

Who Should File Reports

The type of report will, in many instances, indicate who should file it—for example, a report on work completed by the repair foreman, or on lubrication by the head of the lubricating crew, if one is employed. Daily delay and operating reports may be filed by the foreman or the operator of the key machine, with some arguing for the machine operator since the foreman may not be with the machine at all times. Operator reports, if that is the system, naturally should be filed through the foreman, who will check and countersign.

Where several machines make up a unit, there may be a question as to whether reports should be required of the several operators—for example, cutters, shuttle-car drivers, etc. Among other things, such reports might be valuable by focusing operator attention on the need for good maintenance and care in operation. Practically, however, one report, especially if prepared by or with the cooperation of the foreman, usually can provide the necessary information.

Reports on work needed likewise may be filed by the operator, the foreman or the section mechanic, working with each other.

Whatever the number and scope of the various reports, the rule should be a practical system.

Responsibility

Encourage operating and maintenance personnel to work as a team.

Delegate authority along with responsibility to eliminate "buckpassing."

RATHER THAN EMPHASIZING what any particular department should do, the goal in maintenance is the program—what it should be and what it should do. Once the program is fixed, the responsibilities of the operating and maintenance departments become clear. Under this approach, the responsibility for an effective maintenance program is one for the operating management, which also exercises the final authority. For example, experience at one operation indicated that on the working section the face boss should be in control of all maintenance men and functions on the section. Divided responsibility resulted in confusion, buckpassing and failure to keep on top of the job.

But while final authority logically rests with the operating department, the cost, capacity and complexity of the new machines now handling coal production require additional skills

and manpower to keep them running at rated capacity. Consequently, the responsibility for sustained production which only the maintenance department can discharge is increased. In other words, as a practical matter, production depends to a major extent on maintenance, and the maintenance department must be organized and staffed accordingly.

For an indication of how this works out at the face, the foreman has the responsibility for seeing that his unit is operated with a minimum of delays —in other words, that it produces at the maximum rate.

Organization and Manning

Assign sufficient specialists to make inspections and repairs but don't overman.

Take advantage of idle shifts to perform major inspections and repairs.

Keep the overhaul-schedule of equipment on cycle—don't let it lag.

WITH A WELL-ORGANIZED and sufficiently staffed maintenance force, prompt and effective maintenance can be accomplished. The logical approach would be to consider the necessary type of work to be performed. This leads to the "three-echelon" system, which breaks down as follows:

First Echelon

Inspection and minor running repairs at the face or in the pit make up first-echelon work. Normally, inspection is conducted by the section or pit electrician and mechanic, along with the operators, and the same men handle running repairs and adjustments.

First-echelon work also includes servicing the equipment, such as, lubrication, checking and inflation of tires (trucks at strip pits and rubber-tired equipment underground), cable maintenance and repair, and other similar operations.

Typical setups for manning face maintenance are one mechanic or electrician for one or two units, underground, and one or more men for each major class of equipment in the larger strips—for example, (1) shovels and draglines, (2) drills, pumps and compressors, and (3) trucks, tractors, graders, etc. However, organization is subject to considerable variation, and at smaller operations, or at operations with certain types of equipment of a rather simple and rugged nature, running maintenance may be handled by one man or one man and a helper.

Whatever the type of operation, however, the basic principle is assignment of sufficient specialists to a unit or a group of units to keep breakdowns to a reasonable minimum, since overmanning, in maintenance as in other activities, runs up the cost in excess of the benefits in additional lost-time reduction.

Second Echelon

Major inspections involving some opening of cases and enclosures, and also major repair or replacement jobs done during idle periods make up second-echelon maintenance. Part of this work, such as, inspection and replacement of certain units and assemblies, may be done at regular intervals, and part will be done when necessary to avoid a potential breakdown or take care of an actual one.

Such work normally falls to special groups, which may be: (1) permanent task forces or "bull gangs," (2) special groups of men normally employed in the underground or field shop—or perhaps the main shop, or (3) temporary groups made up by assembling the regular section or pit men on off-shifts or idle days. Similar task forces normally handle the maintenance of preparation plants.

Third Echelon

Normally, third-echelon work involves complete overhaul of a machine on the basis of time, tonnage, yardage or hours worked. Underground units and small stripping units, as examples, normally are brought to the shop, or sent to an outside custom shop, for complete dismantling and rebuilding, and large stripping units are moved back from the face or out of the pit to prepared overhaul areas.

Aside from equipment, third-echelon work takes in such other activities as the repair of conveyor belts, large truck tires and similar items, for which some companies have special shops or shop sections. Others use custom shops or manufacturers' repair and service facilities.

Since overhaul, in addition to skill in dismantling and assembly, requires, as a rule, basic skills in metal-working and the like, and normally also requires bringing the equipment to the main shop or a prepared overhaul area, maintenance men handling this class of work are largely kept on it alone, though certain men occasionally may be sent into the mine or pit to handle certain face or field jobs. The number of men and the specialties involved again depend upon the situation at the particular operation.

Spare Equipment

Provide spare equipment, when practical, to reduce the effects of breakdowns.

Furnish extra equipment to replace units scheduled for overhaul.

ONE METHOD OF ALLEVIATING the effects of major breakdowns is keeping spare units on hand, provided the cost of such spare units can be kept within reasonable limits. It is manifestly impracticable, for example, to buy two 30-yd shovels, one to substitute for the other when it breaks down. The goal here must necessarily be one of making sure that breakdowns are kept to the absolute minimum, and that the shovel be maintained in such condition that major overhauls are required only at rather long intervals.

With smaller units, such as underground loading machines, a much-greater opportunity exists for keeping spares on hand without excessive investment. General practice is to provide a spare for each 3 to 5 major production units, such as, loaders, cutters, continuous miners, shuttle cars, etc.

Basically, the number of spares depends upon conditions and particularly on the extent to which preventive maintenance reduces major breakdowns. Time necessarily is involved in getting the inoperative machine out of the way and the new one in, regardless of how close the spare may be. If breakdown time can be kept below that figure without exception, there theoretically would be no need for spare units, except to maintain output during overhaul periods.

But since breakdowns have an annoying habit of causing lengthy delays, there is an opportunity for the spare units, and that opportunity increases as breakdown frequency and time increases. However, there is a drawback. Investment in equipment —and in parts and labor to take care of breakdowns—also increases. The conclusion is that preventive maintenance on the working units is the real goal, and will reduce the need for spare equipment and also the breakdown cost.

A second factor determining spare-unit practice is the overhaul schedule. With intervals of 6 mo to 2 yr on major underground units and on certain surface units, and with overhauls requiring up to a month or more, spares are a necessity if production is to be maintained at a certain level. Usual practice is to take an underground machine out of the

section, or a small portable unit out of the strip pit, and send in the spare unit. Certain underground mines, however, follow the practice of keeping extra completely equipped sections, and transferring the crews for the overhaul period, on the basis that moving men is less costly than moving equipment.

Standardization

Standardize mining equipment as much as possible to reduce maintenance work and cut inventory.

STANDARDIZATION OF MINING equipment, of course, has its limits, and complete standardization would make it difficult to work in new types of machines and thus take advantage of their characteristics. But with fewer types of equipment, including components such as motors and the like, there is a much greater opportunity for learning all about the equipment and how to handle it. Also, repair-part inventories are reduced and the problem of receiving, storing and issuing parts is simplified.

Personnel Training

Schedule training for operating managers, supervisors and operators, as well as maintenance men.

PROPER TRAINING not only increases the knowledge of electrical, mechanical and hydraulic principles, it also makes better electricians and mechanics with an increased interest in their work. Another by-product of conducting training courses is developing unrealized leadership talent among maintenance men.

Operating Managers and Supervisors—While they need not, perhaps, be required to take formal courses, particularly in the details of maintenance, operating managers and supervisors should know what good maintenance means and how to go about getting it—and also keeping it.

An example of a program conducted by the company itself is detailed in the September, 1955, issue of *Coal Age*, p 68. The emphasis is on the electrical side of maintenance; and training facilities include actual trouble-shooting methods on motors and controllers, as well as special wiring diagrams for use in the classroom and underground. The training is done by the electrical engineer, and includes examinations to ascertain progress in learning.

Operators—Here,again, formal courses may be impractical, but since a careless or uninformed operator can raise delay time and maintenance costs significantly, he also should be made aware of what good operating practices mean in both high production and low cost, and of what he can do to prevent machine delays and breakdowns. The logical men to provide him with the necessary information and skill are the foreman and the section or field mechanic or electricians.

Maintenance Men—At least two types of skills are necessary in achieving maximum results in maintenance, repair and overhaul. One type is the basic skill, such as, machining or welding. Three ways of obtaining men with such skills are: (1) hiring men already proficient, (2) hiring graduates of training courses, and (3) setting up company training programs, either conducted on company premises by company-employed trainers, or by outside training establishments to which the employees are sent.

A second skill is proficiency in diagnosing and taking care of trouble on specific equipment units, where a good knowledge of what the unit is and how it operates is imperative. If this skill is not already available, or if it is felt that it could be upgraded, sources of training include:

1. Factory instruction, either at the manufacturing plant itself or through service representatives visiting the mine.
2. Extension courses made available by colleges and universities.
3. Trade-school courses.

Even if only a basic knowledge of electrical and hydraulic principles was gained, the extra insight should result in a better electrician or mechanic, especially if it resulted in his taking more of an interest in his work because it was more meaningful.

ONE ANSWER to the shortage of trained mechanics and electricians is intensive training.

Contract Maintenance

Elect to have major repairs contracted only after weighing all factors concerned.

SINCE OUTSIDE SHOPS serving a region or a large part of the industry have an opportunity to install more facilities and employ more men with the necessary skills because of the larger volume of business, they are increasingly able to offer major-repair and overhaul advantages, especailly to organizations not large enough to support full-scale facilities. Shops now in existence, along with facilities offered by equipment manufacturers, are setup to give speedy, efficient service in overhauling and repairing loaders, continuous miners, shuttle cars and other underground equipment, and bulldozers, small shovels, engines and similar equipment for strip mines; plus conveyor belts, tires, motors and other components. Bit sharpening, drill sharpening and other service shops round out the list.

Rated Voltage

Keep substations within maximum transmission distances to working sections.

Limit the amount of trailing cable on machinery.

Check voltage regularly with reing-type instruments.

Provide protection for trailing cables.

Furnish necessary supplies to repair cables and keep a spare cable handy.

IT IS DIFFICULT to overemphasize the importance of rated voltage at the motor terminals as a factor in maintenance—and in unit production. DC motors, for example, tend to slow down almost in proportion to voltage drop, and slow-acting machines, plus frequent cable and armature failures, tend to result in don't-care operators.

When trailing cables or motor conductors are subjected to high current overloads—one result of reduced voltage—the resistance of the copper conductors increase, the cable drop rises, the voltage to the machine is further reduced, the machine automatically calls for more current with added heating, and the vicious circle continues—possibly to the point of cable or motor failure. Under extreme conditions, copper can be heated to 600 F of higher, at which point it will burn even if nothing else fails before.

As an example of what can happen, consider a 50-hp motor, 0.85 efficiency, served by a 1/0 cable 300 ft long and trying to do the same work at 270 and 180 V. The extra current loss in the conductors at 180 V could approximate 0.4 kw. On this basis, the extra heat generated in 1 hr is equivalent to between 6 and 7 lb of coal. It is almost the equivalent of operating a household stoker inside a jacket of cable or motor insulation.

Maintaining Voltage

Admittedly, the preceding is an extreme case, although not unknown in actual operation, where heat has been known to cause trailing cables to almost explode into flame. It points up, however, the need for maintaining rated voltage at machine terminals, especially in view of the higher horsepowers being crowded into motors used on face machines, and into others as well.

The causes of low voltage include:

1. Substations too far from the working face (see article on electric power beginning on page 70 of this issue for recommendations on maximum distances).
2. Excessive cable length.
3. Inadequate feeder and return capacity.
4. Cables too small.

In addition, excessive heating results from the following:

1. Layering on reels or in piles decreasing cable rating because of inadequate air circulation.
2. Inadequate or no overload protection. Properly rated fuses or properly set circuit breakers should always be used.

Regular voltage checks therefore become a necessity in preventive or production maintenance, and may even warrant the use of recording-type instruments at strategic locations. Otherwise, the section electrician may well be charged with the responsibility for making regular checks. And to make these checks effective, a program of moving up substations and beefing up feeders and returns as necessary must be followed. This might well be the responsibility of the chief electrician, maintenance supervisor or electrical engineer.

Since even under the best of conditions heat is generated when current flows in conductors, and the higher horsepowers now being employed in the same or only slightly larger space aggravate the problem, the best in motor and cable insulation should be employed, such as, asbestos-fiber compounds, silicone and the like. Blowing motors is a well-established method of keeping them cool in certain types of service, and cooling by water jackets is coming into the picture for certain motors subjected to the most-severe duty, as on continuous miners.

Cable Maintenance

Even with rated voltage, delivery of the necessary power to the operating machines usually involves a trailing cable of some type. Aside from low voltage and overload, the major causes of cable failure, particularly underground, are:

1. Ecessive Tension — Install spring-type shock absorbers, keep proper tension on reel, adjust reel to prevent back spooling.

2. Mechanical Damage—Avoid running over cables, replace broken sheaves and guides, avoid pinching cable.

Additional data on failures and their causes appears in a comprehensive discussion of cable types and cable maintenance in the December, 1953, issue of *Coal Age*, p 75.

In the event a cable fails in spite of all precautions, reducing the time lost requires quick restoration of the service. Some ways of doing this are:

1. Use of compression connectors and special hand or power tools for quick connection of the power and ground wires to save time. Special portable welding equipment also is used to make splices electrically in the section (*Coal Age*, January, 1951, p 70). A fairly common failure is trying to keep a cable with too many splices or otherwise in less than top-grade condition in service. The cost of the delays in some instances will repay the cost of a new one in as little as 2 to 4 days.

2. Use of spare cables to permit quick replacement of the entire cable. An alternative with at least certain types of equipment is the use of sectionalized cables, which not only are easy to install but also lend themselves to the quick replacement of a new section for one that has failed.

Temporary splices should be kept to a minimum. One rule allows six. after which the cable is removed and sent to the shop for rebuilding by permanent welded or compression-connected splices and vulcanizing. Some mines remove the cable with a lesser number of splices. At certain operations where attendants are required at substations or other facilities, these men are provided with the necessary repair and vulcanizing facilities and take care of splicing, vulcanizing and other cable maintenance, thus saving the wages of a specialist.

DAILY LUBRICATION

MINE:_____ SECTION NO._____ DATE:_____

LOADER SERIAL NO:_____,_____

Lubrication Points:	Lubricated Yes	Lubricated No	Use Lubricant
1. Frictions RH & LH	☐	☐	Hydl. Oil
2. Gathering Head Gear Case RH & LH	☐	☐	Y
3. Cat Drive Speed Reducer RH & LH	☐	☐	Y
4. Crank Pin Bearing	☐	☐	Z
5. Gear Case Seal	☐	☐	Z
6. Idler Arm	☐	☐	Z
7. Cat Idler RH & LH	☐	☐	Z
8. Conv., Tail Roller	☐	☐	Z
9. Cat Drive Sprocket Bearing RH & LH	☐	☐	Z
10. Conveyor Hinge Pin Upper & Lower	☐	☐	Z
11. Rope Sheaves	☐	☐	Z
12. Conveyor Chain	☐	☐	Hydl. Oil
13. Cat Drive Chain	☐	☐	Hydl. Oil

DUTIES AND RESPONSIBILITIES OF GREASES

1. Properly lubricate all equipment assigned to him.
2. Help float out S/Car crewmen for lunch.
3. Each shift the greaser will clean out the S/Car reel cases and, keep the sheave wheels free of accumulation of obstructive material, also, clean the operators platform and any other accumulation of obstructive material as may be encountered on the wheels and chasis of the shuttle car.
4. Fill to capacity all hydraulic tanks on equipment assigned to him.
5. Grease daily all miscellaneous equipment that may be assigned to his section such as:
   Car Hoist — Conveyors, Head
   Elevators — and tail pieces.
   Piggybacks
6. After performing regular assigned duties, the greaser is at the disposal of the foreman in charge.

PERIODIC MAINTENANCE

	Date: Month	3	3			
	Date: Day	13	13			
Periodic Inspection	Operating Shifts:	1/2	3/4	5/6	7/8	9/10
Motors 20 Shifts	Loaders	6771				
	S/Buggies					
	T/Trucks					
	Machines					
	Piggybacks					
Clutches 40 Shifts	Loaders					6771
Clutches 40 Shifts	S/Buggies					
Cable Reel 40 Shifts	S/Buggies					
	T/Trucks					
Contractors & Switches As Scheduled	Loaders	6771				
	S/Buggies					
	T/Trucks					
	Machines					

Periodic Shuttle Car Lubrication

	Date: Month	3		
	Date: Day	13		
S/Car Serial No.	Operating Shifts:	1/2	3/4	5/6
3220	S/Cars Day			
	S/Cars Nite			
	Symbol			
	Date Greased			
3223	S/Cars Day			
	S/Cars Nite			
	Symbol			
	Date Greased			
	S/Cars Day			
	S/Cars Nite			
	Symbol			

INSPECTION REPORTS and lubrication charts insure repair and adjustments before breakdown.

Fault-Finding — Failures in long high-voltage cables, such as on strip shovels, can result in a long search for the trouble point, with attendant loss in production time. Electrical fault-finders now on the market cut this time loss to a minimum by giving a quick and accurate indication of where the failure occurred. Or, the mine can make its own (*Coal Age*, May, 1953, p 108).

Lubrication

Establish a lubricating schedule and standardize on the number of lubricants used.

Provide necessary equipment for applying lubricants properly.

Keep seals and fittings in good condition.

Have reports and records kept on all lubrication.

Responsibility

Attainment of efficient lubrication requires acceptance of perhaps three responsibilities.

1. Selection of lubricants and lubrication equipment. This responsibility normally falls on the maintenance department, though the importance of lubrication might well warrant the employment of a lubrication engineer —at least where a company operates several mines and a large number of producing units. Sources of help in lubricant selection include lubricant suppliers and the engineers of the machine builders. The services of these experts should be used.

2. Establishment of a lubricating schedule. Scheduling, with attendant reports and records, is perhaps one of the most-vital elements in efficient lubrication, and here again the responsibility rests on the maintenance department or the lubrication engineer.

Lubricant Application

The third responsibility in lubrication is getting the job done, which responsibility may be placed on the maintenance department alone or may be shared by the maintenance department and the machine operators and/or section or pit mechanics and electricians. The lubricating system varies with the type of machine and when and where it is used. The three general systems are:

1. Hand Lubrication. This usually involves grease guns or spout-type or other oilers for fluid lubricants. Where this is the practice, lubrication normally is handled by either the machine operator or the mechanic or electrician assigned to the machine or section, or by a special oiler, as with large stripping units. Lubrication can be combined with inspection and running maintenance, as with belt conveyors underground, for example.

Hand lubrication involves more

SHOVEL NO. _____ **SMALL SHOVEL LUBRICATION RECORD** MONTH OF_____ 19

DAY OF MONTH	1	2	3	4	12	13	14	15
AFTER INSPECTION OF LUBRICATION WORK IS COMPLETED, SHOVEL OPERATOR AND PIT FOREMAN MUST SIGN REPORT, IN ABSENCE OF PIT FOREMAN, LOADING FOREMAN SIGNS FOR LUBRICATION WORK COMPLETED USE CHECK (√) SIGN SHIFT	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm	1201 8am 4pm
HOURS OR MINUTES DEADHEADING								
HOURS OPERATED LOADING COAL, ORE, ETC.								
PARTS LUBRICATED PIT NO.								
(1) Truck Frame and Propelling Machinery (Lower Works)								
All Fittings Below Deck Lubricated								
Circle Rollers Lubricated								
All Cat Assembly Fittings Lubricated								
Propel Bearings Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
(2) Revolving Frame and Machinery Units (Upper Works)								
All Fittings in House Lubricated								
All Open Gears Lubricated								
Enclosed Gear Case Oil Level Checked								
Hydraulic Oil Level Checked								
Gasoline or Diesel Engine Oil Changed								
Light Plant Oil Changed								
Electric Motors and Generator Bearings Lubricated								
Flexible Couplings Lubricated								
Air Compressor Oil Changed								
Air Filters Cleaned								
(3) Front End Equipment								
All Boom Fittings Lubricated								
Boom Support Cables Lubricated								
Hoist Cables Lubricated								
Open Gears and Sliding Surfaces Lubricated								
Enclosed Gear Case Oil Level Checked								
All Bucket Fittings Lubricated								

(1) TRUCK FRAME AND PROPELLING MACHINERY

PARTS TO BE LUBRICATED:
Drive Tumbler Shaft and Transverse Propel Shaft Bushings.
Longitudinal Propel Shaft and Propel Brake Shaft Bushings.
Center Pintle Thrust Washer Oil Pump (Note Instructions On Pump)
Center Pintle Bearing Bushing.
Take-Up and Idler Tumbler Bushings.
Steering Clutch Shifter Collars.
Steering Clutch Sliding Jaw Guide Bars.
Propelling Bevel Gear Cases.
Cat Side Frame Gear Cases
Swing Rack Teeth
Roller Track Bars.
Roller Pins.

(2) REVOLVING FRAME AND MACHINERY UNITS (Upper Works).

PARTS TO BE LUBRICATED:
Vertical Propel Shaft and Upper Propel Shaft Bushings.
Propel Bevel Gears and Sliding Propel Gears.
Hoist Pinion Sleeve Bushings.
Hoist Gear.
Drum Shaft Bearings
Intermediate Shaft Bearings
Intermediate Reduction Gear Case.
Vertical Swing Machinery Gear Case.
Vertical Swing Shaft Lower Bushing.
Electric Motors and Generators
Hydraulic Pressure System
Operating Lever Shaft Bearings, Bell Cranks.

(3) FRONT END EQUIPMENT

PARTS TO BE LUBRICATED:
Boom Point Sheave Bushings.
Shipper Shaft Bushings.
Saddle Block Bushings
Dipper Handle and Saddle Block Slide Plates.
Shipper Shaft Gear Case.
Intermediate Gear Case.
Intermediate Shaft Bearings.
Dipper Padlock Sheave
Dipper Door Hinge Pins, Padlock Pins, Ball and Handle Pins
Wire Ropes

PART	HOW OFTEN TO LUBRICATE	TIME TO LUBRICATE
Point Sheaves Crowd Fittings	3 times per shift 3 times per shift	1. Start of shift 2. Two hours after starting 3. At lunch time
Fittings in House	2 times per shift	1. Start of shift 2. Middle of shift
Circle Rollers	1 time per shift	1. Start of shift
Cat Assemblys	Mud and Water Conditions 3 times per shift	1. Start of shift 2. Two hours after starting 3. After lunch time
	Dry Pit Conditions 2 times per shift	1. Start of shift 2. After lunch time
	Deadheading Every 1,000 feet	1. Start before deadheading
Open and Partially Enclosed Gears Sliding Surfaces	Normal Operating Conditions 2 times per shift on loading	1. Start of shift 2. Lunch time
	Deadheading As often as dry spots appear, or approximately every 1,000 feet	
Hoist Cables	Every 24 operating hours, Never let hoist drum cable grooves run dry.	When convenient When dry
Boom Support Cables	Once a month	While machine is idle
Enclosed Gear Cases	Check oil level once a shift	Start of shift
Hydraulic System	Check oil level once a shift	Start of shift
Air Compressor	Check oil level once a shift Clean air filters and change oil once a month	Before starting

Center Pintle thrust collar at lower end is lubricated by hand pump on truck frame at idler tumbler end. Operate pump plunger two or three times, twice a shift.

GASOLINE OR DIESEL OPERATED MACHINES: Clean air filters, change oil and filters each 100 operating hours. Always drain while oil is hot.

Always wipe off grease fittings to avoid forcing dirt into bearings.

Shovel operator, pit or loading foremen will be held responsible for checking lubrication work done during their shift, also the keeping of monthly lubrication record chart on shovel up to date.

Pit or loading foremen and operator are to sign record chart at end of their respective shift.

It shall be the duty of day shift pit foremen to see that there is enough lubricating materials and equipment on shovel to carry over the afternoon and midnight shifts at all times

Inspections of mechanical and lubrication conditions of shovel will be made by maintenance supervision and lubrication engineer during all shifts.

Lube Engineer

GOOD LUBRICATION MEANS

- SAFETY
- LOWER OPERATING COSTS
- FEWER SHUT-DOWNS
- MORE PRODUCTION
- JOB SECURITY

LUBRICATION EFFICIENCY is promoted by definite scheduling and reporting, as with this form for small shovels.

transfers and containers, as a rule, and makes for more complicated distribution in addition to increasing the risk of contamination. In view of this, one company (*Coal Age*, May, 1956, p 68) maintains central storage tanks (in old mine cars) at central points in working sections. The tank is filled from a large oil car by the supply crew, and is pumped through a hose to a convenient point near the face units.

An improvement in small hand gun reloading is the use of manufacturer-filled grease cartridges, which reduces the reloading time and eliminates contamination.

2. Lubricating Trucks and Special Crews. Such trucks are used both underground and at strip pits. Hand lubrication may be desirable for

several reasons, including low working height, cramped quarters, or the type of unit, such as, a belt conveyor. However, since individuals with other duties frequently are called upon for lubrication under this system, the chance of human error is greater. Hand lubrication also increases the chances of contamination, and may require stopping the units during the working periods, thus reducing output.

The preceding are among the reasons why a number of mines have placed responsibility for lubrication on special crews and have provided them with lubricating trucks. A typical underground truck usually is operated by a crew of two men, who visit all units in the mine or a section of the mine once a day on the off shift. The truck usually is equipped with tanks for two types of lubricants, with a third tank for hydraulic oil, and may be provided with hoses for blowing fittings, motors and the like as necessary with air from the compressor used in dispensing the lubricants. Where the truck is track-mounted and offtrack equipment is employed, the offtrack equipment may be brought to the loading station once a week, for example, for thorough inspection and lubrication, with lubrication by hand at other times. The truck crew also fills lubricant containers for hand lubrication.

As for results, one mine bought a truck to serve eight loaders and nine cutters, and in the first 18 mo of use had only three bearing failures. Lubricant consumption was reduced 65% in the same period. Another mine using a truck reports that a loader can be greased completely in 10 min.

Trucks for strip equipment also may include fuel-dispensing equipment. One such unit comprises a gas-powered compressor, lubricating pumps, four lubricating hoses on reels, and four fuel drums with the necessary hoses. Air pressure is used for dispensing fuel as well as lubricants, and the unit serves tractors, drills and other smaller mobile units.

3. Centralized Automatic Lubrication. Minimum manpower and positive lubrication at all times are among the reasons for the rise in use of centralized automatic lubricating systems in coal mining. These systems dispense either grease or oil—more usually grease—and among other advantages reduce the chances for contamination to almost nothing, since the lubricants usually are dispensed from the original containers or if not, with a minimum number of transfers. Applications of centralized automatic systems include:

1. Loaders, cutters, continuous miners and shuttle cars underground. In some instances, the systems are designed to give the bearings a shot whenever the machine hydraulic system goes through a cycle, thus requiring no manual attention whatever. Some, however, prefer to leave part of the lubricating cycle to the operator because with automatic initiation there is the possibility of over-lubricating, with grease getting into, for example, motor windings.

2. All bearings in preparation plants, with the possible exception of motors. Automatic systems, in fact, have included dispensing of grease to underwater bearings on sludge conveyors.

3. Heavy-duty off-highway trucks, including wheel and steering bearings. For a description of how it is done at one operation, with substantial savings in truck time, lubricants and replacement parts, (see *Coal Age*, August 1955, p. 60).

4. Large stripping shovels and draglines, and possibly other smaller units. One company divides between hand and automatic lubrication of stripping equipment on the bases of (a) cost of special lubricating equipment v. the type of machine and its expected life, and (b) the fact that in many instances the man still would be necessary. Other major factors in this company's program (*Coal Age*, January, 1952, p 76) include lubricant standardization, detailed scheduling of lubricant application, reports on lubricant application, and prevention of contamination.

Results reflect (1) a reduction in the cost of lubricating materials—from 3.-05c per ton in 1944 to 2.20c in 1950, in spite of increases in material cost, (2) a reduction in maintenance expense, and (3) a reduction in the losses in production time. The program includes both pit and preparation equipment, and at that time the reduction in cost of maintaining stripping equipment was estimated at $75,000 a year, and of maintaining a dry preparation plant (centralized lubrication), $20,000 a year.

Seals and Fittings

Effective lubrication, in addition to all the other factors involved, depends upon (1) the lubricant getting into the bearing, and (2) the lubricant staying in the bearing. Therefore, fittings, oilers, grease cups and the like must be of the proper type and must be in condition to function as needed. Otherwise, no lubricant. A No. 1 job of any men handling lubrication therefore is to check to make sure the fittings and lubricators are in operating condition, and to report promptly if they are not in shape.

Bearing seals are unglamorous but nevertheless are vital to make sure that the lubricant is retained so that it is available for the job it is called upon to perform.

Scheduling

An efficient lubrication program depends upon definite scheduling of the work, accompanied by definite instruction as to the type of lubricant to be used. This means a written document for the information and guidance of all who have anything to do with lubrication, and this document may also serve as a report on work done. Tags enclosed in plastic envelopes may, for example, be tied to tractors, with one side of the tag showing points to be lubricated, type of lubricant to be used, and when lubrication is to be done, and the other side serving as a record of lubrication performed. Similarly, more comprehensive schedules may be posted in strip shovels and preparation plants, or supplied to foremen and mechanics underground. In any event, the goal is to have something definite and thus avoid hit-or-miss application, buckpassing and the like.

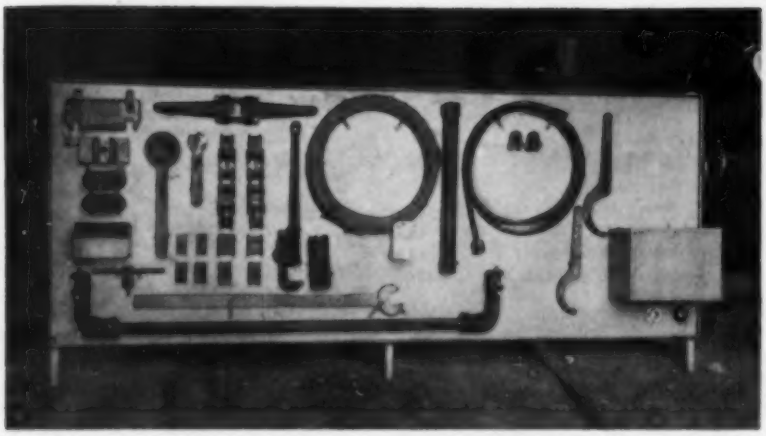
Reports and Records

Unless somebody checks, adhering to an efficient system in lubrication, as in all other activities around the mines, is practically impossible. This means reports and records which, even though they involve paper work, provide the basis for intelligent operation and control.

Reports may be rather simple in nature, merely recording that a certain machine was lubricated on a certain date. An important item in any report, however, is whether certain bearings refused to take lubrication or took too much, since this is a signal that trouble is probably in the making. A rise in quantity used on each machine or in each application is a further signal that machine condition is deteriorating, or that certain parts need attention. And if experience has shown that adequate lubrication can be secured with certain quantities of materials, figures on quantities used also will reveal waste and loss through contamination or otherwise.

Lubricant Selection

The recommendation of the equipment manufacturer are the starting point in lubricant selection, with the second major source of data the service departments of the oil companies. A third source of information, pro-



PARTS BOARD for underground sections contains items frequently used. Box mounted at right corner holds parts catalogs and wiring diagrams.

vided proper records are kept, are the lubricating and delay reports, which may indicate that a change in type is necessary. When all the preliminaries are completed, lubricants then should be bought on performance rather than on general representations, and the rule should be the highest possible quality in view of the penalties now suffered as a result of equipment breakdowns. The latter, for example, comes into consideration when gear oils, for example, are being specified. Use of the extreme-pressure type covers all applications with a quality product and eliminates the chance of misapplication in lubricating the operating units.

Standardization—Too many types of oils or greases lead to confusion, misapplication, contamination and loss. Careful study of the lubricating problem will show, in many instances, that a lesser number of types of high quality will do the job, since the variety of lubricants available include many with the necessary spread in characteristics fitting them to several applications.

As an example of what standardization can accomplish, one large stripping organization, also operating a large and modern preparation plant, cut the number of lubricants from 29 to 9, as follows:

	Types	
	Before	After
Motor oil, heavy-duty detergent	2	1
Gear oil, all enclosed gear cases	4	1
Antifriction-bearing grease		1
Plain-bearing grease	5	1
Open gears	3	2
Cable dressing	5	1
Compressor oil	3	1
Hydraulic oil	7	1
Totals	29	9

On-the-Job Supplies

Keep spare repair parts close to all working sections.

Provide adequate storage space for spare parts.

IF A PART IS not close at hand, what might be only a minor breakdown can turn into a major stoppage if the item, such as a chain link or hydraulic hose, is missing, requiring a special trip to the supply house or the main shop. Limiting down time therefore requires keeping an adequate stock of the smaller, frequently used items in the section or pit, where they are readily available for the mechanic or electrician. Where heavier, less frequently used parts or critical assemblies are involved, one or more can be kept at a central location, perhaps on a truck or carrier, but still handier to the working sections or pit than in the main shop.

To prevent loss or damage, section parts should be kept in a supply cabinet, a parts box, or in lockers, drawer's, etc., in the foreman's or repairman's shanty or office. Some mines also have found it advisable to keep certain special tools with the parts so that they are handy when needed. Lamps or other heating facilities should be provided for parts subject to damage by moisture.

Mobile Repair Units

Furnish means by which troubleshooters can get to breakdowns quickly.

THE REPAIRMAN'S JEEP, with space for carrying parts and supplies and lockers or compartments for tools, has become a fixture at many underground mines because of the speed with which it can deliver both men and materials to the scene of a breakdown. Similar units also speed up the work of wiremen, bratticemen and other service workers. Other mobile maintenance units include welding trucks—gas and electric—where there is an opportunity to use such equipment in fresh air.

Skid-mounted "maintenance centers" (*Coal Age*, September, 1955, p 78) are among the newer types of mobile repair units. Designed particularly for trackless mining and moved by hitching it to a shuttle car, the centers consist of 4 x 5 x 12-ft steel tanks with flat tops providing bench surfaces for work. Among other advantages, a supply of spare parts is always within 100 ft of the face.

For bringing machines to fresh-air locations, and for other purposes, including moves, crawler-mounted pullers or carriers have been found very useful at a number of mines, especially in low coal. And where machines must be moved long distances, such as loaders, miners and shuttle cars to main shops, lowbed transporters speed up the operation and save wear and tear on the units.

Where pullers are not available, several tricks may be employed to move disabled machines—for example, a drill motor with an adapter to power the crawlers on a loader for short moves.

Mobile maintenance equipment at one strip operation includes the following, aside from greasing and fuel trucks:

Small-tool truck for all types of small hand tools and parts normally required on maintenance jobs.

Large-tool trailer for transporting heavy tools required in major jobs on big stripping units.

Flat trailers for moving wood blocks, cribbing and the like.

Special heavy-duty trailer for hauling buckets and shovels up to 100 tons.

Small-parts truck.

Truck-mounted crane with boom sufficiently long to handle all lifting jobs necessary in maintaining 40- to 50-yard shovels.

Welding trucks.

The number and variety of units reflects the fact that this is a very large operation. At a smaller strip plant, this number and variety would not be practical, but a welding truck plus a general repair truck, or one

truck for both purposes, represents possibly the minimum of mobile units.

Communication

If for no other reason, a good communication system from the face or pit to the main office and repair shop normally will pay for itself through reduction in breakdown losses alone. In strip pits, two-way radio is one of the answers, and includes certain mobile units such as in the superintendent's car, the repair forman's car or truck, and the cabs of the key stripping units. A good telephone or trolleyphone system yields the same results in deep mines.

Mine Shops

Locate shops at the most economical places for deep and strip mine.

ALTHOUGH A FEW DEEP MINES make a practice of maintaining machines up to the stage of semi-overhaul in the working section, lack of space, the difficulty of doing welding, light and coal dust, among other things, normally dictate the transfer of major repairs, replacement of assemblies and semi-overhaul to shops maintained for that purpose. Some of these conditions do not prevail in strip pits, and consequently there is a greater opportunity for doing second-echelon work away from the shop. And with large stripping units, the only practical way to work on them is in the field in special repair areas, though some components and assemblies are processed in the shop or shops. In preparation, also, the nature of the plant and equipment also dictates doing a major part of the work on the job, though parts and assemblies may be removed for shop repair and return.

Shop Location

Deep Mines — Distance and whether or not the equipment must be hoisted up slopes or shafts are among the factors involved in location of deep-mine shops. A third is facilities for quick moving of units from the face to the shop and back, such as, special transporters. Where good transportation facilities exists, and hoisting is not involved, it may be possible to locate mine shops on the surface and thereby get the advantage of space, natural light and the like, including convenience, at a somewhat smaller expenditure. But where the distance is great, and where hoisting is involved, there are strong reasons for locating the shops underground. With proper planning and design, they can be made almost as convenient as surface shops—and as efficient—and have the major advantage of being closer to the actual working sections.

Moving the shop as the mining location shifts also is possible with certain types of mining—contour in particular, as well as auger. Some such operations use small prefabricated buildings mounted on skids or trucks as shops or supply houses or both, moving the unit or units as needed as the mine opening moves around the outcrop.

Certain types of maintenance work, such as cable repair, may be done in small specialty shops set up at substations or other points where attendants are necessary to take advantage of what otherwise would be idle time.

Strip Mines—Central location and convenient access from highways, both on the property and off, are among the considerations involved in locating strip-mine shops. Frequently, these considerations result in the shop being located with the other mine facilities, such as, the mine office and the preparation plant, especially since big units are necessarily repaired in the field, and trucks, tractors and small units can be brought in under their own power or by the use of transporters, even when they are not required to come to the preparation plant regularly. An exception might be a truck garage and shop where the trucks haul to field stations or to rough cleaning plants moving coal to central plants by rail after rough cleaning.

Specialty shops employed by some stripping organizations include a portable welding shop, fabricated from corrugated steel, and mounted on wheels, and large enough to go over a truck or other unit. This facilitates body and other repairs where the unit cannot readily be brought into the shop without dismantling.

Shop Facilities

Even the simplest deep-mine shop for major repairs, replacement of assemblies and the like should be equipped with a pit, hoisting facilities and a parts store room, plus the necessary special tools required for the work done. Parts-cleaning equipment should be installed if possible to speed up this operation and facilitate subsequent work.

At the other end of the scale, mine shops may be large and elaborate and able to handle everything up to complete dismantling and reassembly of all types of machines. One shop of this type, located near the bottom of the hoisting shaft, includes high-intensity lighting, a general repair section with two pits plus overhead cranes and small hoists, two bays for shuttle-car service with hoisting facilities, an office, cabinets for parts, a room for repair and servicing of shuttle-car wheels and hydraulic-jack units with monorail crane, and a cleaning recess with permissible-type steam cleaner supplemented by a refuse stall.

Tools include saw, floor-type drill press, vises, bench drills, floor grinders, hydraulic press, welding machines, and portable electric and air grinders. Facilities also include 32 tool cabinets built into the walls, and a compressor.

In-Plant Facilities

Though not a part of shops, certain permanent facilities of a shop type serve very useful purposes in certain maintenance applications. Examples are compressed air and welding gas lines and outlets in preparation plants, and arc welders in preparation plants and strip shovels. Time saving is the major advantage.

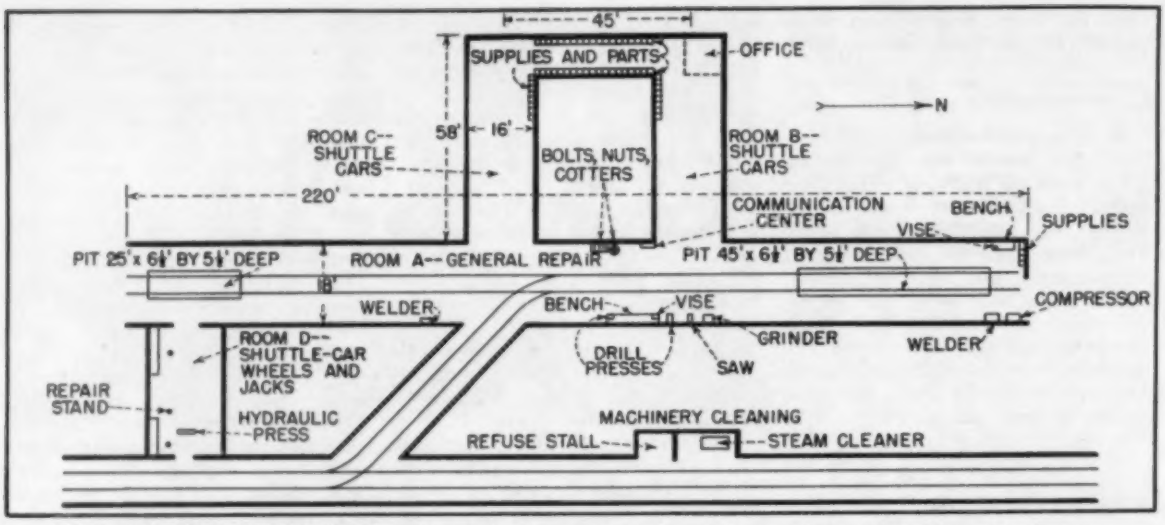
Overhaul Scheduling

Make sure that equipment is overhauled as necessary, regardless of the standards used to determine such overhaul.

FIVE OF THE STANDARDS for determining when overhauling is necessary are:

1. **Elapsed time**—in weeks or months. In other words, machines are taken out of service at specific intervals for overhaul.
2. **Operating time** in hours or days.
3. **Tonnage or yardage handled.**
4. **Inspection.**
5. **Personal judgment.**

Each of these standards has its supporters among maintenance and operating men, though more of them seem to operate on the basis of a combination of inspection and hours operated or tonnage or yardage handled. Where the number of units is large, on the other hand, supporters of the elapsed-time standard point out that a rigid schedule is necessary to permit getting around to all the machines without jams resulting from two or three coming up for overhaul.



MODERN MINE SHOP includes machinery-cleaning section and special rooms for certain equipment and parts.

CENTRAL SHOP features special work areas for various types of equipment. Note parts bin close to repair area.

A sixth system is, in affect, no overhaul—or overhaul only at long intervals. Under this system, known as unit replacement, overhaul is accomplished by replacing assemblies, such as rear conveyors on loaders, crawlers on shovels and the like, removing the replaced assemblies to the shop for overhaul and storage until another assembly on another machine comes up for replacement.

What might be called a seventh system is practiced at least one mine where the coal is low, belts are employed, and the difficulty of handling a major breakdown is much greater than in thicker coal. At this operation, each new panel is started with equipment that has been completely overhauled, the crew merely transferring from a worked-out panel and leaving the machines to the maintenance force.

Main Shops

Plan to centralize main-shop work where transportation is to your advantage.

Design shops to match individual operations such as, size of operation, type of equipment, type of work done and other factors involved in planning a central shop.

MAIN SHOPS generally are defined as establishments where work beyond the removal and replacement of parts and assemblies is done. It is difficult, however, to be precise as to what main shops are, since they vary widely in goals, scope of work handled, and equipment. Normally, however, their main business is major repair and overhaul, and to facilitate this they usually include machine tools and other equipment not found in mine shops. On the other hand, main shops can function as mine shops, and they may also, in some instances, include facilities for manufacturing repair parts and even complete equipment units, such as, for example, pumps and shaker pans.

Central Units

Where several mines are operated by a single company, the question arises as to whether to have a main shop at each operation or a big central shop for all. The trend seems to be toward centralizing main-shop work in one plant, especially where good highway and rail connections are available. The advantages include:

1. Less duplication of equipment and facilities, in turn providing an opportunity for adding extra facilities in the main shop without increasing overall expenditure.

2. An opportunity to provide additional repair and maintenance skills because the volume of work is sufficient to warrant employment of certain specialists.

3. An opportunity for increasing efficiency because of the greater volume of work in one place.

4. Less duplication of parts and supply inventories, and consequently a reduction in inventory, as a result of concentration of operations.

Shop Types

Main shops may include types aside from the general overhaul and repair units devoted to machine reconditioning. Eamples are: conveyor-belt shops, wheel-reclamation and welding shops, truck-tire shops, minecar shops and so on. Such shops may be separate or may be incorporated into the main shop via separate rooms, bays and the like, and, of course, are warranted only when the volume of specialized work is sufficient to make them practical.

Shop Layout

Since size of operation, type of equipment, type of work done and other factors vary widely, no prescription can be given for a typical main or central shop. A summary of layout and facilities for three specific shops, however, is as follows:

Strip-Mine Service Center—L-shaped shop, warehouse and garage structure, with 66x215-ft garage as the base of the L; next, a 59x32-ft warehouse; and completing the upright of the L, a 59x84-ft machine shop. Thus, the warehouse is conveniently located between the machine shop and the garage. The garage is fitted with 10 rollup doors, and handles the maintenance and repair of all gasoline, butane and diesel equipment and pumps (but not motors), as well as serving as the headquarters for the maintenance of two small walking draglines. Extra engines, and some heavy spare parts, including some rear end transmissions, are kept in a fenced-off enclosure in the garage, which is equipped with a 2-ton hoist on an overhead track.

The warehouse includes a 25x25-ft partitioned section in one corner serving as the electrical shop. Warehouse facilities include convenient outdoor storage for heavy shovel parts while lighter parts that can be brought inside—via a 5-ton chain hoist mounted on overhead rails—are stored on the floor. Bins, of course, are provided for the smaller items.

The machine shop does work for the garage, electrical shop and the field force, and is equipped with three radial drills—one large and two small; horizontal lathe, 20-ft bed, 36-in swing; 12-in lathe, 18-in utility saw, shaper, bolt machine (up to ¾ in), three hand-welding machines, automatically controlled gas-cutting unit, automatic continuous welding machine, two 5-ton and two 2-ton chain hoists. Work done includes building dipper sticks 63 ft long.

Deep-Mine Central Shop—Three-building establishment, all connected with doors wide enough and high enough to permit passage of portable cranes, thus avoiding the use of heavy overhead cranes and hoists; windowless Quonset construction, with fluorescent lighting. Unit functions equipment are:

Building 1, 40x100 ft, rebuilding shuttle cars, loaders and continuous miners; steel work benches, two bench drills, vises, two 300-amp portable welders, gas-welding equipment, air-operated impact wrenches and portable drills, test panel for mercury tubes.

Building 2, 40x100 ft, rebuilding rubber-tired cutters, rubber-tired coal drills, roof drills and other mining machinery; wall-type work benches, special floor-type work bench for repairing shuttle-car wheel units, two welding machines, cable vulcanizer, cable-conductor welder, and 150-kw rotary converter for DC test power.

Building 3, double Quonset 60x80 ft plus single Quonset 60x40 ft, building up and machining parts for mines and preparation plants; wheel press; 20-in, 48-in and two 24-in lathes, milling machine, radial drill, 20-in shaper, bolt threader, slotter, metal-cutting band saw, bit cutoff machine, blacksmith forge, air compressor for the three buildings, two degreasers, heating boiler, welding machine, and floor controlled bridge crane across lathe bay; also toilet and shower facilities in 20x20-ft room.

Deep and Strip Shop—Though designed primarily for the complete rebuilding of underground equipment, one shop also handles certain work for the company's strip operations. Size of the two-story building is 213x95 ft inside, and it includes offices and a supply room. A modified assembly-line procedure is followed, with types of machines assigned to certain bays, and parts removed to service bays for reconditioning before return to the unit. An outside cleaning station is a major contribution to quality and efficiency.

While, as noted, shops vary widely in character and facilities, certain practices and equipment lead to higher quality of work at lower cost. These include: good light, convenient lockers and work benches, special benches and stands for certain work (shuttle-car wheels, for example), supply depots in the shops themselves or at least close at hand, hoisting equipment for lifting and moving anything heavy, including such things as shafts into lathes, and power-operated tools—impact wrenches, etc. Cleaning and degreasing equipment contributes greatly to comfort and efficiency in repair work.

Maintenance Materials

Use hardsurfacing materials whenever possible.

HARDSURFACING PRODUCTS are are an example of materials that cut maintenance cost by increasing the life of machines and parts subject to wear, reducing the number of replacements and consequently saving not only in parts and materials but also in labor for replacement.

Examples of the other materials and parts that may be employed to lengthen machine and part life, reduce breakdown time and cut the cost of maintenance include:

1. Stainless and other alloy steel, aluminum and so on for strength, light weight and corrosion resistance in mine cars, truck bodies, stripping dippers, cages and skips, and so on. Light weight, provided there is the requisite strength, in itself reduces the maintenance load, or light weight with high strength permits building up parts without increasing total weight, thus reducing the chances of failures.

2. Stainless steel, manganese-steel and bronze for reducing wear and corrosion in coal screening.

3. Special alloys, bronze, rubber, other corrosion- and abrasion-resisting materials for pumps, valves, fittings and other equipment handling water and water with various solids.

4. Use of lime, by means of automatic feeding equipment, in wet-preparation plants where acid is a problem to reduce corrosion.

5. Cast iron, alloy, asbestos-cement, lined or plastic pipe for mine and other water lines to resist acid.

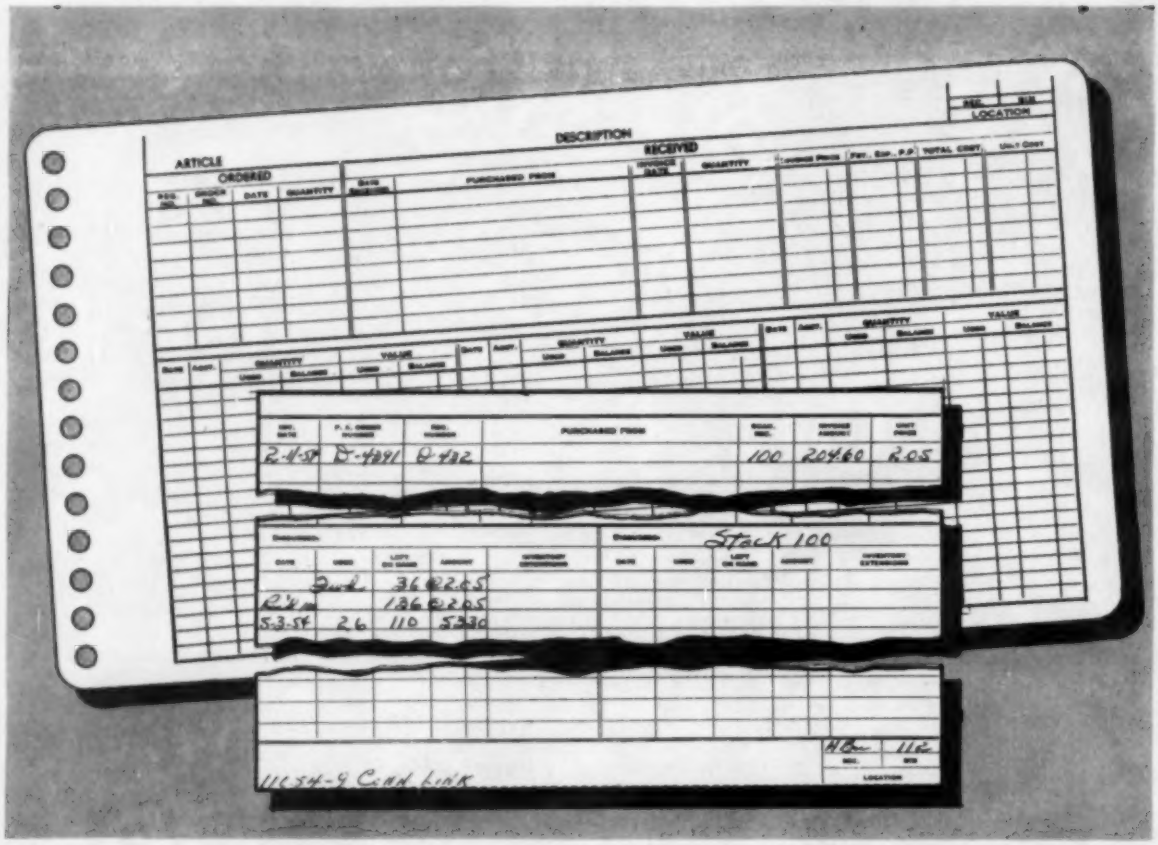
6. Rubber, tile, sprayed and sand-cement and other corrosion- and abrasion-resisting materials for tanks and storage bins. Some companies have made complete bins of steel-supported glazed tile to resist abrasion and corrosion.

7. Glass, stainless steel and other wear-resisting materials for chutes, conveyor bottoms.

8. Aluminum, protected-metal and other weather-resistant siding and roofing for preparation plants and other structures.

9. Protective coatings and paint.

10. Silicone, asbestos and other long-lived heat-resistant insulation for electrical equipment.



PERPETUAL-INVENTORY SYSTEM provides a running record of supply receipts, disbursements and costs. Cards shown here are for loose-leaf ledgers (above) and tray-type files.

LOOSE-LEAF CARDS for the perpetual-inventory system are kept in ledgers to permit easy checking.

HANDY DESK equipped with filing compartment for parts catalogs aids supply clerk in locating part numbers.

ACCOUNT NO. LOADERS - 1-101

SHEET NO. _____

REPORT OF MATERIALS AND SUPPLIES USED AT _____ MINE FOR MONTH OF _____ 19____

DESCRIPTION OF MATERIAL AND SUPPLIES USED	QUANTITY USED	UNIT PRICE	SUB-ACCOUNT NUMBERS: LOADER #1	LOADER #2	LOADER #3	LOADER #4	LOADER #5	LOADER #6
TOTAL								

MONTHLY USE REPORTS such as this lend themselves to summaries by account or function numbers, or by individual units. Here it provides a means of keeping track of parts costs by individual loading machines.

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Trend Markers—Supplies

Increased cost of parts and materials is reflected in strong emphasis on close inventory control.

Going beyond the standard "supply-distribution report" and requiring more detailed reports on the use of parts and materials by machine and by working section growing as a means of more effectively controlling cost.

Trend to central supply houses to serve multimine operations gathering momentum for economy reasons. Advantages, include reduction in total inventory and opportunities for buying supplies in larger quanities at reduced prices.

SUPPLIES AND MATERIALS including repair parts make up a large part of the cost of coal. Surveys by *Coal Age* indicate coal mines spend an average of approximately 85¢ per ton for supplies alone. The low, usually at the smaller operations, is as little as 40¢ per ton or less and the high is over $1.

Keeping machines and men working requires an adequate flow of parts and materials. A good supply system promotes efficiency and lowers cost in four major ways:

1. Machines and men are able to produce more by eliminating interruptions resulting from lack of parts and materials.
2. Inventory is controlled and kept to a minimum.
3. Waste prevention and loss of parts and material are controlled.
4. Parts and materials are received, stored and delivered at minimum cost.

What is involved in a good supply setup and how to get it are the subjects of the material which follows in this Supply Guidebook.

Inventory Control

Keep an adequate supply of items on hand that are essential to controlling production cost.

Regulate supplies by reordering on time. Don't permit bins to get empty.

Select the type of warehouse that suits your individual mine.

THE QUESTION most often asked about supply inventory is: "What should be carried in terms of dollars and cents?" Actually there is no one answer. Inventory, if too high, means that money will lie idle. On the other hand too low an inventory can mean increased production delays and higher production costs. Among other things, the level of supplies at individual mines depends upon mine location and size. Inventories range from as little as $25 to

$30 per ton of daily capacity up to $150 or more per ton at mines remote from manufacturing and distributing centers. The average appears to be in the neighborhood of $50 to $60 on hand per ton of daily capacity.

Under coal-mining conditions, the inventory level involves a fair amount of personal judgment based on experience and an analysis of parts and supply use in relation to time for normal replenishment. Some of the factors involved in arriving at a solution include:

1. Cost of item or a class of items in relation to production cost increases incurred if the item is not on hand when needed—for example, spare armatures or motors. For instance, how much, at the most, would a rotor failure on the main shaker-screen motor involve in payments for non-productive labor, for power for ventilation and pumping during the production interruption, and so on? And would the cost be reduced if a complete motor was on hand instead of only the rotor? Or should the possibility of a stator failure be the controlling one and thus dictate keeping a complete motor ready for replacement?

In all these, it is assumed that the tonnage loss could be made up at a later date and that the extra cost on the breakdown day is the major factor, though if the breakdown occurred near the end of the shift the loss might be reduced by better preparation in the mine for the following shift and consequently a higher tonnage and higher efficiency on that shift.

From the preceding, it can be concluded that there is no easy sure-fire formula for relating parts inventory to breakdown losses, though there is, of course, at least an approximate relation. Careful study of the problem is the best guide to informed judgment of what is needed.

2. Rate of use in relation to time required to reorder and get delivery of replacements. Experience normally will indicate the rate at which, say, controller fingers of a certain type are used. If new supplies could be secured in a month, then the maximum on hand at any one time theoretically would be a month. However, it may be considered desirable to have an additional reserve, which becomes largely a matter of judgment. Or, the total use in, say, 6 mo, might be so small that it would pay to keep that much stock on hand to avoid the extra clerical and other effort involved in ordering more frequently. Also discounts for volume may be a factor in quantity ordered and consequently the total on hand at any one time.

3. Central warehousing vs. warehouses at individual mines. Where one company operates several mines, it normally is considered more economical to operate one central warehouse provided certain conditions exist. These include:

A. Reasonable distances from central warehouse to mines to keep down delivery time.

B. Good highways and good trucking facilities to permit fast deliveries.

Where these conditions exist, central warehousing, as noted, is considered feasible and economical, except for certain types of supplies, such as, timber, rail and the like. Of course, a certain volume of other parts and supplies must be kept at each mine and, in fact, at each deep-mine or pit face, to facilitate maintenance and prevent operating delays arising out of such things as lack of timber, etc.

A major advantage of the central system is reduction in total inventory because it is not necessary to duplicate each item at each mine, particularly the larger, more-costly units, since, with fast delivery, a small number of, say, armatures can serve the several mines. Otherwise, it might be considered necessary to keep one at each property.

4. Cooperative stocking. Where a part or a component is large, costly and requires considerable time to repair or, if completely wrecked, must be manufactured from scratch, it is possible for a group of companies in an area to buy one such component or part and rotate it around as needed. Thus, several companies—for example, a group of strippers using identical machines—are protected against major production losses with a minimum outlay for spare parts of a key and costly nature.

5. Independent warehousing. Where manufacturers, their agents and independent supply houses have branch or main establishments close to the coal fields, maintain stocks of the desired items and provide quick delivery, it is possible to use them as the source for many items, thus cutting down on both inventory and on company-owned warehousing facilities.

6. Price trends. If one is willing to risk the hazards of estimating future trends, it may turn out to be desirable to run up the inventory of parts and supplies—at least in part—to offset expected price increases, or to curtail purchases in anticipation of decreases. A more-rare occasion for perhaps increasing inventory is anticipation of decreased availability as a result of strikes, government control of critical materials, and so on.

Control Systems

Establish a good inventory control system, such as, the perpetual inventory.

WHILE THE PLURAL "systems" is used in the title to this section, coal mines have largely settled on the "perpetual" system of inventory control. Basically, this system shows quantity and cost of units and materials received, quantity and cost of units and materials issued, and quantity remaining on hand at all times. From this, it gets its name "perpetual."

Two of the methods of keeping a perpetual inventory are:

1. Cards on each bin, particularly of the smaller items, on which the records of receipt, disbursement and quantity on hand are kept.

2. Cards designed for keeping in tray-type files, so-called rotary files, or in loose-leaf ledgers.

Wide use of the file-card system indicates that it is the handiest and surest. With bin cards or other systems, it normally is necessary to make an inspection or separate notes as the parts and materials are issued to determine if reordering is necessary, and those who have used the bin-card system report that there is a greater possibility of running short through failure to note that the time for reordering has come.

Inventory cards may be made up specifically by a mining company to meet its own needs, or cards, files and systems may be purchased from specialists in business machines and business records, who can, if desired, provide forms and equipment for even punch-card tabulating and record-making where the number and volume of supply items is large.

The accompanying illustrations show two types of cards provided by business-record specialists. One is designed for ledger use and the other for tray-type files. Both show purchases, including, in one type, cost of shipping, and both show cost and quantity received, cost and quantity issued and cost and quantity left on hand after each disbursement. The ledger form also includes a column for the account number to which the supplies are charged.

Both also indicate warehouse section and bin number where the item can be found.

The perpetual system provides a running record of activity in supplies, and also an easy means of making periodic summaries of use. In some instances, certain types of supplies, such as timber when bought locally as offered, may be excluded from the perpetual system. However, when there are exclusions, it becomes the responsibility of some supervisor or employee to make sure that (a) the items are not overbought, (b) that the quantity is not permitted to drop below the danger point, and (c) that data are supplied for the periodic supply-use and inventory reports. Most mines prefer to have everything in the system.

The records used in the perpetual systems also provide a convenient means of determining when reordering must be done. In other words, when the quantity left on hand after the last disbursement reaches a minimum shown by experience, a new order is placed. By the same token, the records may be used to prevent overbuying by establishing a top limit on quantity on hand, and also for maintaining an approximate average level between the minimum and maximum.

Certain types of cards are designed to permit the use of "flags," or colored tabs, to facilitate reordering and the compilation of periodic reports on use of parts, supplies and materials. A green plastic tab on the bottom of the card may be slid to the center the first time an item is issued in a monthly or other report period, and a red tab on the opposite side also may be slid to the center as an indication that the item is to be reordered when the next weekly requisitions on the purchasing department are prepared. The flags make it unnecessary to check each card for either preparation of the distribution report, or for reordering, thus saving considerable time and making it easier for the supply clerk.

Whatever the control system employed, it should be supplemented by an actual physical inventory. The practice varies between 6 mo and a year at most mines.

Even at small operations, an accurate record of receipts, cost and use is essential for wise and economical use of supplies, and while the perpetual or other good inventory system requires some paper work and the assumption of responsibility by some person, it can save both money and production time in the same proportion as in the larger operations.

Use Records

Compile detailed reports on the use of parts by each major machine. Submit monthly distribution reports to mine and operating management.

THOUGH IT REQUIRES extra paper work, there is a growing tendency to go beyond the standard "supply-distribution report" and require more detailed reports on use of parts and materials by machine and by working section for the purposes listed in the preceding paragraph. The standard distribution report, usually prepared monthly, shows supplies charged to classes of equipment, such as, shuttle cars, and to mining functions, such as ventilation, timbering and the like. For convenience, each equipment class or mining function is provided with an account number.

Where account numbers are used, some hold that the daily or other delay reports (see the Maintenance Guide-book in this issue) provide—at least by inference—sufficient information to determine whether supplies are being used properly and economically. Those who are adopting the more detailed system argue that definite and positive information is a necessity to prevent waste and loss through abuse and carelessness, particularly in view of the rising cost of everything that enters into mining.

Whatever the system, order forms, reports and records are essential for the proper evaluation of supply use. To start off with, nothing should be issued without an order, properly signed, stating what is wanted and where it is to be used. This applies even if the item is for current use, such as, timber, or is to go into, say, a section parts depot to replace some item used in maintenance. And for a check and appropriate action, summaries of supply use should be prepared at regular intervals for the information and use of mine and operating management.

The monthly distribution report previously referred to and prepared by account number is one form of report to mine and operating management. Where more detailed data are desired, the form or forms may be expanded to show items charged out to each machine, to each working section and to each general function, such as pumping, thus providing a better opportunity for determining whether abuse is running up parts cost for a particular loading machine, as an example, or whether certain sections are taking a larger-than-normal supply of timbers, perhaps indicating waste.

Aside from reports derived from the regular requisitions, special reports may be required of certain officials and mine employees. For example, a single carbide-tipped cutter bit can cost $1.25 or more, and, therefore, some operators feel that it is in order to ask the section foreman or machineman to report daily on number on hand at the start of the shift, number received for replacement, number sent out for grinding, number destroyed in operation, and number on hand at the end of the shift. Similar records could be required for other small and relatively costly items, such as, roof bolts, steel ties and the like.

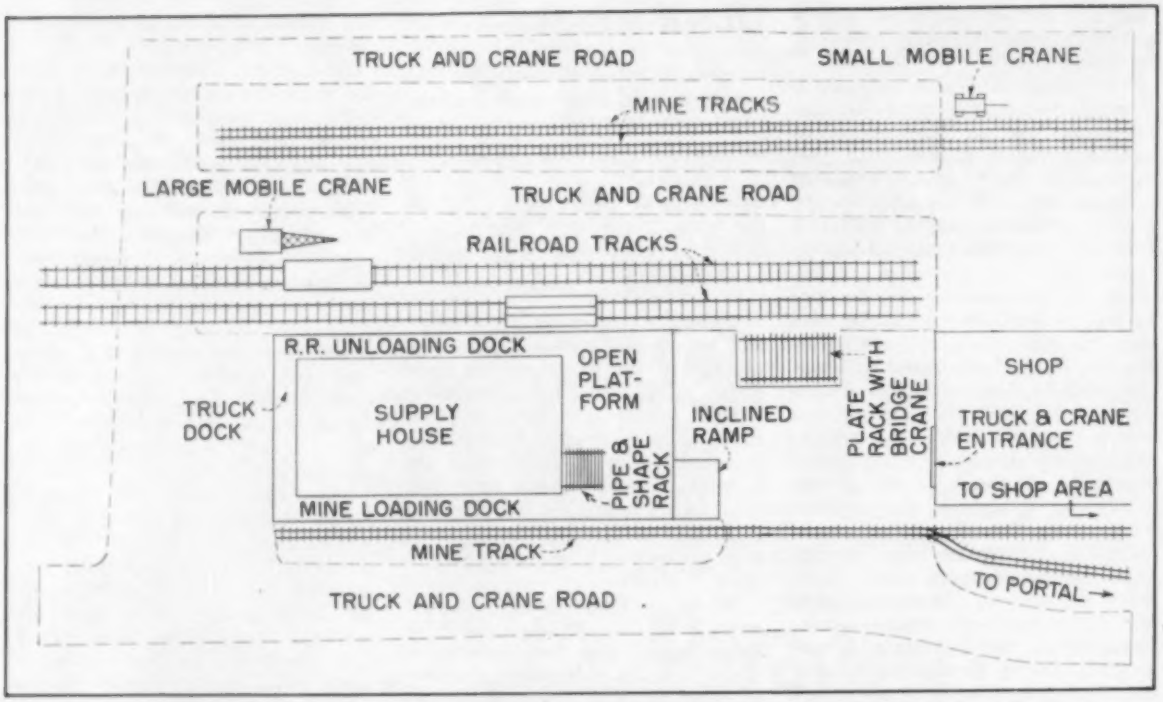
Since they are required to report on use, the men responsible naturally would take care to prevent loss, and if the record showed excessive destruction, for example, there would be an opportunity to check to find out why. Incidentally, such records also would reduce the number of small items, such as, cutter and drill bits, that would find their way into the railroad cars, particularly if the responsible men were required to turn in the worn-out or broken items.

To wrap up a detailed record system, it naturally should show transfer of certain materials, such as, steel ties, from one working area to another, thus guarding against, among other things, possible loss through carelessness or buck-passing. And if such things as timber were salvaged for use elsewhere, the records should show how much came out of a particular section and where it went as a means of gaging, among other things, the effectiveness of a salvage program.

Allocation of Stocks

Provide necessary parts and material at or near the point of use. Make studies to determine type and quantities of such supplies.

EVEN WHERE ONLY ONE mine is involved, the satellite principle of stock allocation is necessary to keep production interruptions to a minimum. In other words, stocks of frequently used machine parts, as an example, should be kept close to or in the pit or underground section for the use of the section or pit electrician or mechanic. Otherwise, major delays may occur as a result



CONVENIENCE, EASY ACCESS AND PROTECTION feature yard designed for truck and mobile-crane operation. Accompanying supply house has receiving and loading docks on three sides.

of having to send outside or to the main supply house for a needed item.

Type of unit and experience indicate the types of parts and materials to be kept in such satellite pit or face depots. Normally, replacements for such stocks are charged to operating cost when they leave the main supply house. If it is desired, as discussed previously, to keep accurate use records, the section or pit electrician or mechanic can file reports showing use of items by machine number, thus enabling operating management to keep track of where parts and materials go. Rather than a separate report, the section mechanic's or electrician's daily delay and repair report (see the Maintenance Guidebook) can show what items are used and where.

Where two or more mines are involved and the central warehousing system is employed, allocation might be along the following lines:

1. Principal stock of repair parts at the central warehouse.
2. Subsidiary stocks at the central repair shop, provided it is not adjacent to the central warehouse.
3. Subsidiary stocks at the mine shops.
4. Section stocks in the working sections or pits for running repairs and maintenance.
5. Stocks of ties, timbers, roof bolts and similar items at the individual mines, since it is more convenient and less costly to have such materials delivered directly to the mines for storage and distribution rather than rehandling them from a central point. In fact, even where only one mine is involved, it may be more convenient to provide separate facilities for receiving, storing and distributing (a) machine parts and smaller items, and (b) larger, bulkier items used every day the mine runs.

There are, of course, many modifications of the preceding systems to suit individual conditions.

Storage and Handling

Plan storage layout for efficiency, convenience and protection.

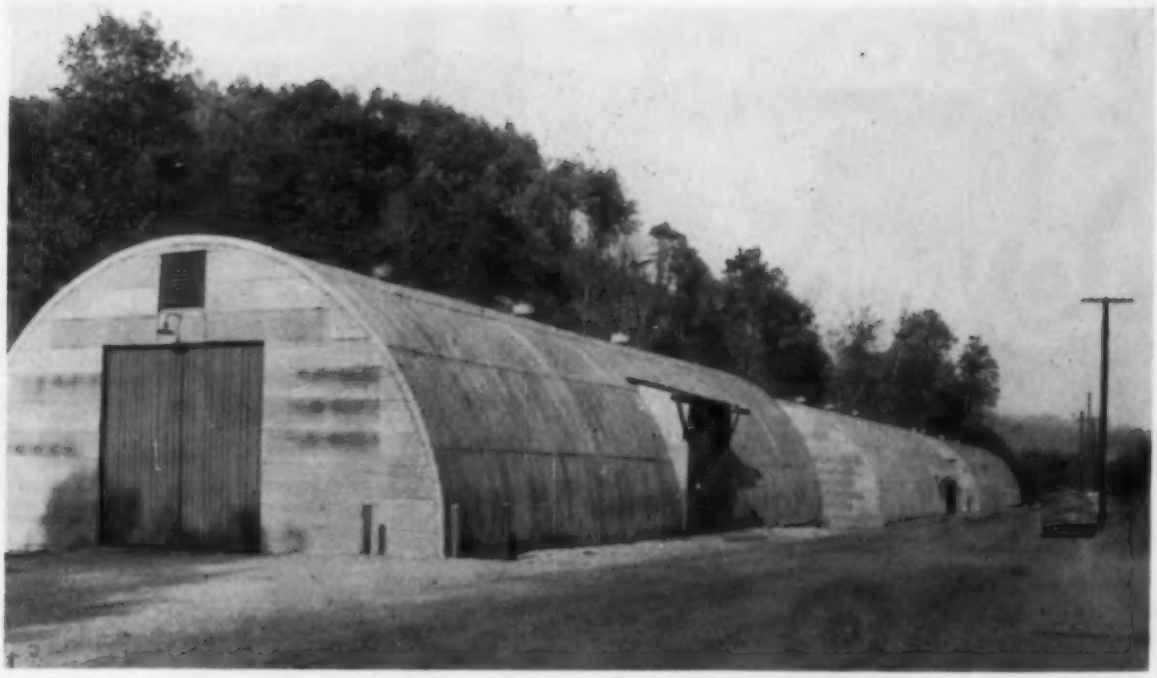
Include in supply-house facilities bins for small and medium-sized items, hoist where necessary, push-type carts and so on.

TYPE, SIZE AND COST of specific items normally dictate methods for receipt, storage and issuance. Thus, depending upon these factors, both enclosed and open storage are employed at mines. Enclosed or covered storage includes both regular supply buildings and also sheds for certain items requiring less protection.

Open or yard storage is satisfactory for timber, steel ties, rail and the like including heavy equipment items that are not appreciably affected by rust and other deterioration as a result of exposure to rain, snow, dust and the like. Where the items are made, for example, from copper and lend themselves to theft, enclosed storage normally is dictated to prevent losses of this type. Shed storage may be desirable for pipe, structural shapes, plate and the like to prevent excessive rusting and also avoid difficulties with snow and rain in storing and handling. However, shed storage rules out, in most instances, the use of mobile cranes in handling such items, and the ability to use such equipment may outweigh the disadvantages of open storage.

Storage Layout

While the storage layout will vary from mine to mine, the plan shown at the start of this Supply Guidebook illustrates some of the basic principles involved in achieving efficiency, convenience and protection. In this instance, the shop is near the supply house and thus a separate shop supply is not required. The principles illustrated include:



QUONSET BUILDING SERVES AS SUPPLY HOUSE at one coal-mining property. Large doors permit trucks to enter building to load and unload. The interior arrangement facilitates receipt, storage and issuance.

1. Receiving and loading dock completely surrounding the warehouse. This is a practice than can be followed if desired, but it may not always be necessary to surround the supply house with docks, though provision should be made for sufficient dock space both for receiving and for loading mine equipment. The docks in the setup illustrated are at the right height for receiving material from railroad cars or trucks, and for loading materials into mine equipment without excessive lifting or lowering.

The design permits running hand trucks or other mobile equipment directly into cars or trucks in most instances for unloading, and also permits lowering items directly into mine equipment. It will be noted that for the most part items are taken into the supply house from one side and then moved directly across the mine track. If desired, the truck dock may be reduced to one-truck width, extended inside the supply house, and equipped with rollup doors so that loading and unloading can be done completely out of the weather. The railroad unloading and mine loading docks also may be roofed, but a roof may prevent use of mobile equipment for handling heavy items.

2. Open storage planned so that as heavy material is unloaded it can be placed so that it is convenient for loading into mine equipment. Roads are located so that mobile cranes can be used for unloading railroad cars or for lifting heavy items out of storage into mine equipment. These same roads permit unloading such items as mine props and timbers directly to the mine trucks if desired.

3. Use of power-operated handling equipment. The mobile crane, with various attachments, including clamshell for sand and gravel, and fork for props, rails and the like, or other mobile handling unit materially reduces labor and also the hazards involved in handling heavy parts and materials. With a fork-type grab, for example, two men can load a car of ties in less than 1½ hr. Aside from cranes, mobile handling units include motorized wheelbarrows, motorized high-lift bucket-type loaders and carriers, high-lift fork trucks, crane trucks and so on.

Overhead Elimination—Added flexibility is achieved in the yard illustrated by the complete elimination of trolley wires—a growing trend in the design and operation of supply yards. Elimination of wires also eliminates a hazard, which still is present even if continuous guards are installed. Without trolley wires, material can be stored and reclaimed from either side of the mine track, and high-lift mobile cranes can handle materials across one or even two tracks without difficulty. Cars are handled in such yards by battery locomotives or, more commonly, by locomotives powered by gasoline or diesel engines.

4. Open platform with inclined ramp provides open storage for certain parts and materials and also makes it easier to get equipment, such as, shuttle cars, loaders and the like out of railroad equipment and down to mine-track level. Handling of heavy items on the platform can be done with the mobile cranes, or the platform can be equipped with crane rails and a hoist. An alternative is a crane track extending out of the supply house to the platform both for handling materials on the platform, or for moving them inside to floor storage. The plan illustrated also shows an open plate storage with traveling crane and hoist. Plates are stored on edge between stanchions.

As noted, there are many variations in layout to suit individual mine conditions. Among them are incorporating the supply house into a larger structure serving, for example, a

REELS FOR CABLES and similar materials facilitate storing, handling and measuring out pieces and thus save time and labor in the handling of supply items.

MECHANIZED EQUIPMENT speeds unloading of roof-bolts from truck into cars.

truck garage and repair depot on one side, and a machine shop and general repair shop on the other. Or the supply house may parallel the shop with a track in front of the doors to the shop for loading parts and materials into the mine equipment brought in, say by a diesel or battery locomotive. Thus, most of the loading equipment is under cover.

Supply-House Facilities

Supply houses include both bin storage for small or moderate-sized items, and floor storage for heavier units. The floor-storage facilities at one new supply house include a basement for cool storage of rubber-covered cable, conveyor belts and other rubber items. Access to the basement is by 25-ton hydraulic lift, large enough to handle even the heaviest reels of cable and belt, which can be rolled on and off.

Some supply houses include a mono-rail and hoist for handling heavy units into and out of the floor-storage area, and storage facilities for such heavy items, include, in addition to open floor, racks for, say, spare armatures.

Other facilities which have proved successful in simplifying the handling of supplies in warehouses include: sectional steel bins with adjustable shelves; drawer-type and rotating bins for small items; clear plastic chest and drawer units for miniature units; shafts and reels mounted on walls or stanchions for convenience in paying out and measuring cable, hose, rope, etc.; peg racks for V-belts and similar items; and platform-top push trucks for moving items to and from bins, especially if the warehouse occupies a rather large floor space.

If bins are built up higher than eyesight level or arm's reach, trolley or wheeled ladders or steps save time and reduce the possibility of injury. One wheeled step, for example, includes springs which give when a man puts his weight on the steps and thus provides solid footing.

Light should be ample to read tags, nameplates and the like, and the sources should be placed so that it is relatively easy to see into the backs of shelves or bins, especially those high up.

In addition to provisions for hand trucks, some companies have found it desirable to provide aisles wide enough—at least in the areas where heavy units are stored—to permit small push-type mobile cranes or

MOBILE CRANE with various attachments, including clamshell and timber fork shown here handles heavy materials in the supply yard and can unload a car of ties in less than 1½ hr.

even motorized units to be brought in for moving say, armatures to a neighboring shop or to cars or trucks for mine delivery. This presupposes floor construction strong enough to stand up under the traffic and also floors at ground or loading level, or ramps at convenient points, to permit mobile units to travel in and out from ground or other level.

Other ideas employed to facilitate storage and handling include: Easy access to bins, for safe and quick disbursement of parts by the use of permanent stairways and balconies. Monorails equipped with hoists and armature racks mounted on wheels (see illustration) save space and facilitate handling of heavy parts.

Special Supply Houses

Design and locate powder houses in accordance to state and federal safety authorities and recommendations of the Institute of Makers of Explosives.

Set oil houses and oil-storage facilities apart from other surface units and build them of fireproof materials.

Provide sand houses with adequate capacity and locate them so receiving, drying and dispensing is controlled by gravity, if possible.

SUPPLY FACILITIES falling into what might be termed the special class are: powder and oil houses, sand-storage and drying establishments, and even portable or semi-portable pit or mine houses.

Design and location of powder houses is a matter of following the recommendations of state and federal safety authorities and the Institute of Makers of Explosives. Factors to be considered with other types include:

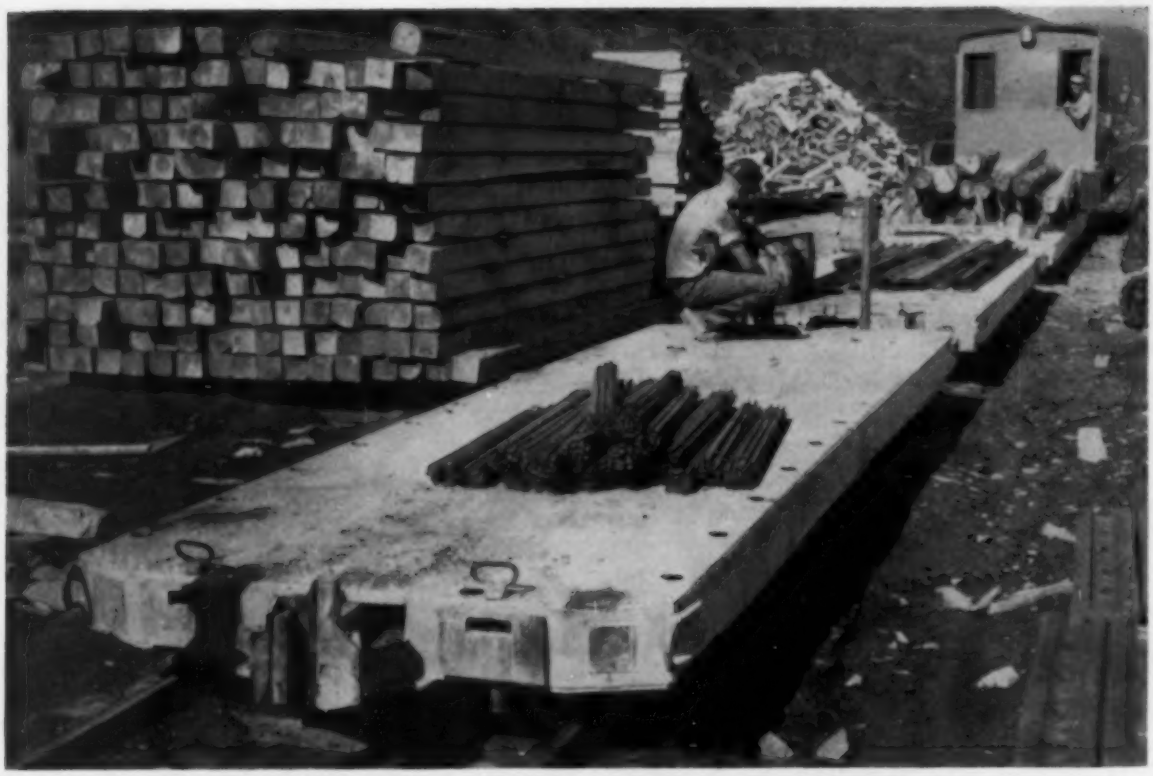
Oil Houses—There is good reason for putting oil houses and oil-storage facilities apart from other surface units. Oil and grease are, after all, flammable. However, there is no reason why they cannot be located for easy receipt of supplies either by truck or rail. As a matter of fact, convenient, clean and safe facilities for dispensing are as much factors in oil-house design as storage.

Designs most nearly meeting these objectives include: steel and concrete construction, racks that hold drums in proper position for dispensing, hoists or other mechanical facilities for handling drums, and provisions for catching drip and spillage. Fixed racks should be provided with inclined ramp rails to permit rolling drums up to position, unless chain hoists, are used. Chain hoists, incidentally, make it easier to replace drums without handling of others, as do tilting-type racks with castors, which may be pulled out of position, run to the storage area and tilted to permit taking off the drum, after which the process is reversed to put a new drum into position.

An example of a well planned oil house is shown in the accompanying illustration (Texas Co., "Lubrication of Coal-Mine Machinery"). Note that oil drums are delivered on a platform at truck-bed level. After drums are emptied they are rolled to the end and under the top rack to the outside.

Sand Houses—Terrain and other considerations affect sand-house design and location. If possible, the facilities should include storage for a specified number of truck loads. In hilly country, where sand is received by truck particularly, it may be possible to build the road up on the hillside so that trucks can dump directly to the bin.

The preceding comments presuppose gravity flow from the wet storage bin to the drying stove or stoves, and from the stoves or dry-sand bins to the locomotives, sand cars or borehole to the mine bottom. This gravity



VERSATILE FLAT-BED TRUCKS facilitate supply delivery to working sections in coal mines. Diesel locomotives are finding wider use in yards as a means of eliminating overhead and making operations easier.

flow materially reduces labor in all phases of receiving, drying and dispensing sand, and this saving may warrant a substantial investment in bins and gravity-handling facilities which, in some instances, are almost or completely automatic.

Though not yet possible in too many mining areas, sand-handling facilities may be eliminated completely by depending upon outside suppliers for drying and delivery. At one operation, the custom drier delivers the sand in oil-type drums ready for movement into the mine.

Portable Supply Houses—Under certain circumstances, a "portable" supply house becomes quite convenient in addition to providing protection and promoting order in dispensing supplies—particularly machine parts. One circumstance is stripping where frequent moves are made from one location to another. Another is deep mining of the contour type, where the main opening keeps moving around the hill. Under such circumstances, a number of mining companies have bought small prefabricated buildings and mounted them on skids or trucks for towing from one location to another.

Supply Delivery

Provide facilities for supply delivery on the surface and underground for quick delivery with minimum labor.

THE MOTOR TRUCK in its regular form is the work horse in supply and delivery on the surface. In its special forms, especially at stripping operations, it includes grease trucks—usually designed for actual application of the grease at the point of use as well—fuel trucks and utility trucks. And at some operations, the final stage in storage and delivery of explosives—at strip mines, for example—is handled by small rubber-tired units designed for towing on the bank by tractor, relieving the regular truck for other duties.

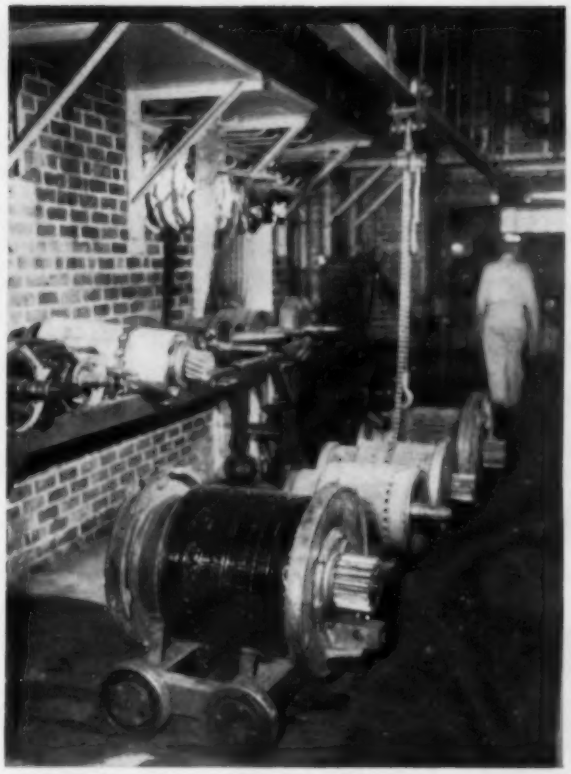
Delivery between supply house and shop, for example, where the two are not too far apart and are connected by a hard-surfaced roadway, may be handled by hand-pushed lift cranes, motorized cranes or special motorized flat-bed trucks.

Where trucks are used to deliver supplies from a central supply house to more than one mine it is important that order and delivery schedules be worked out. As an example, requisitions from the various mines should arrive at the supply house at a designated time to permit the supply clerk to fill the orders before the supply crew is due to arrive. When the supply crew arrives supplies should be ready for loading and delivery to the mines as scheduled.

Borehole Supply—One new wrinkle in speeding up delivery to shops or distribution facilities underground is the supply borehole. One such borehole (*Coal Age*, March, 1956, p 94) is fitted with a 24-in casing (large enough for an emergency escapeway) and a headframe with a 5-ton hoist. Spotted at the right place, a borehole sometimes can save a long underground trip for parts and other small items.

Underground Delivery

Where mine cars are employed to haul coal, the same track is used for delivery of supplies—perhaps to the face or, if trackless mining is the rule, to the point where the rails end. Even with belt haulage, convenience in handling supplies and men has led a number of operators to put supply



MONORAIL EQUIPPED WITH HOIST and armature rack on wheels save space and facilitate handling heavy parts.

24-IN BOREHOLE, here photographed in a snowstorm, cuts the time involved in getting small parts underground.

tracks alongside the belt conveyor—or in a parallel heading. Battery locomotives may be equipped for pulling the equipment on such auxiliary track systems to avoid having to put up trolley wire. And in some instances, rubber-tired tractors and trailers are employed to take in supplies, eliminating track completely. With either system, the added convenience and saving in time and labor is held to warrant the installation of the track or the preparation of the special roadway for the trackless battery units.

Where belts are installed for haulage, especially single panel units, they may be provided with reversing facilities for movement of supplies back to the face. In some instances, at least, special inching and jogging controls have been provided to facilitate handling long crossbars and other items without hazard to men or to the belt and conveyor.

Facilities for delivering supplies to the faces of rooms equipped with conveyors include:

1. Dolly trucks running in shaker lines.

2. False pan lines, or lines of pans alongside the operating line, which which are loaded with supplies and pulled up as the main line is extended, the face pan going into the operating line and the supplies to other face operations. At the same time, a new pan is added at the outby end and loaded with supplies until the place is halfway up, at which point the loaded line will complete the place.

In pitching places, small hoists may be included in the equipment at the face to pull timber and other materials up from the track on the gangway below.

Mobile Units—For the most part, unless pitch or some other condition prohibits, the mobile unit operating either on or off the track is the most efficient and flexible unit for supply delivery. In trackless areas, the mobile unit may be a shuttle car, though using a shuttle car on the working shift may result in interference with production. If supplies are delivered on the off-shift, the shuttle car may well double in brass. And if crawler trucks are used for moving shortwalls, these same trucks may also be employed for handling heavy units, such as motors, drives and the like. Special crawler-mounted pullers and carriers also have been built for moving drives and for handling materials.

The extra advantages of special equipment, including availability at all times, design for handling materials and the like, have led, among other things, to a substantial growth in such equipment as battery-powered tractor-trailer units, especially in trackless areas. Some mines also have used the equivalent of a straight truck with a battery for power.

For rail delivery, the mine car, as noted, still is the mainstay. However, special cars and trucks provide a number of advantages, including better design for loading, unloading and protection of materials and supplies. An example is the low-height flat-bed car with steel deck and holes all around for stakes, which lends itself to handling almost any shape or size of material or part. Such cars are used on moderate-pitch slopes as well as on the flat. In tandem and properly loaded, such cars also can move rails and long timbers, though the special rail truck still is a standard item at most operations.

Other special cars which a number of operations have found advantageous include the following:

1. A utility car with a cab for the snapper equipped with plastic windows, and compartments for such items as steel ties, miscellaneous

SUPPLY CAR EASES HANDLING of conveyer pans, parts and supplies in thin seam.

OIL-HOUSE OPERATION is facilitated by such equipment as these castor-mounted tilting racks.

track and trolley supplies, coal augers, roof bolts and the like.

2. Sand cars especially designed for the service, including sides low enough for easy unloading to sand boxes.

3. Enclosed powder cars with sliding doors and insulated couplers.

4. Special insulated detonator cars with steel doors, wood and rubber lining, and compartmented drawers.

5. Special ballast cars with bottom doors designed for spreading ballast in the track.

Special handling facilities at unloading or transfer stations underground can materially speed up the job and reduce the hazards. Oil drums, for example, may be lifted off trucks or out of cars by a small chain hoist and run back into the underground depot on a monorail. Similar facilities also may be installed for handling timber, roof bolts and other bulky, lengthy or heavy materials and parts. Handling is facilitated by bundling or typing the materials, such as, timbers, to make it easier to hook onto them with the hoist. In fact, some companies ask that lumber and certain other materials be bundled and strapped by the supplier to facilitate handling all along the line. Properly designed, underground stations of this type make it easy to unload and store materials until the face equipment is ready, then facilitate reloading for distribution.

To further speed the handling of supplies at the mine, one company, for example, provides special supply cars to permit loading as the supplies arrive at the mine. This includes special cars for hauling timbers, roofbolts, rockdust, rails, ties, brattice materials and so on. The big advantage is that supplies are only handled once.

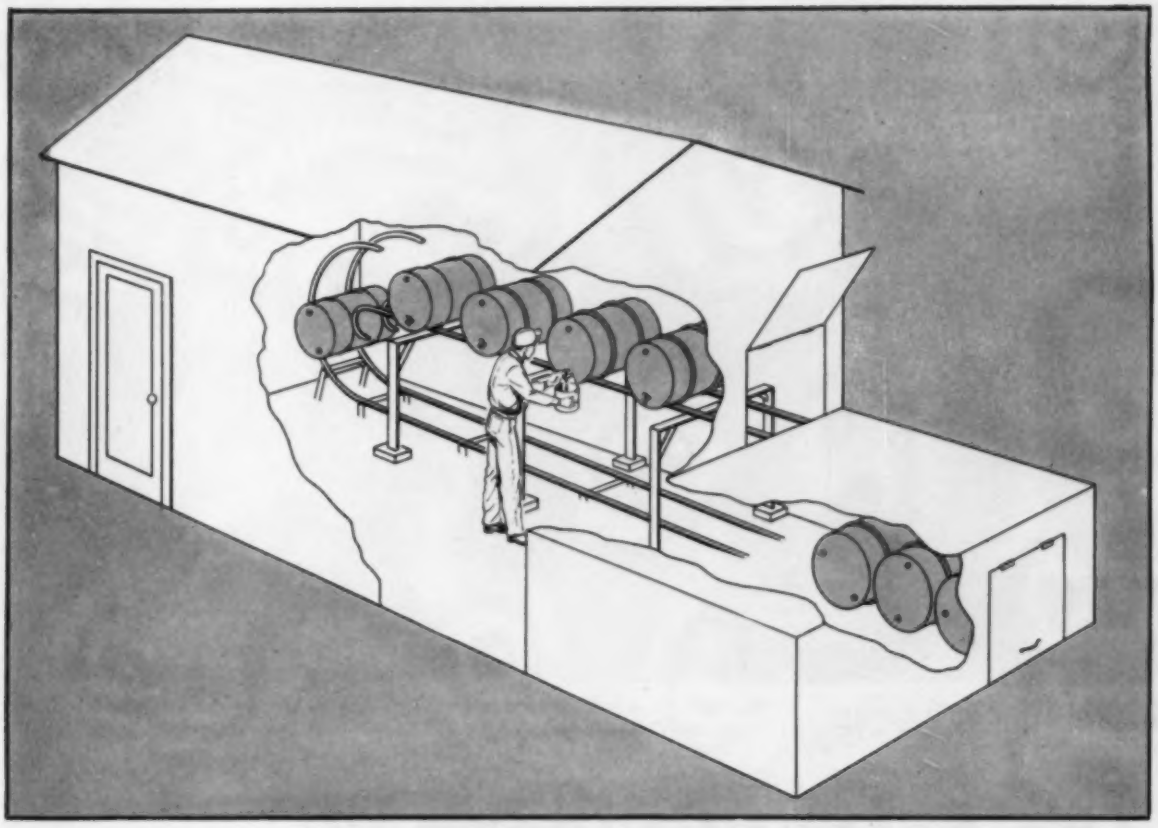
Preventing Waste and Loss

Reduce waste and loss of parts and materials by setting up rules and standards and following through.

THERE IS NO PARTICULARLY easy road to reducing waste and loss in parts and materials, but results can be achieved by, among others, the following methods:

1. Good Records—Where supplies go and how much (see "Use Records").

2. Education—Some companies have found, for example, that a display of certain supply items, each tagged with its cost and accompanied by some pertinent words by the superintendent or foreman, brings home



TYPICAL LAYOUT OF AN OIL STORAGE HOUSE permits easy handling of oil drums by one man.

to men the costs involved in loss or carelessness and consequently leads employees to handle materials and parts more carefully.

3. Prevention of Machine Abuse—This is largely a matter of training both operators and supervisors in how abuse results in breakdowns, lost time and an increased cost for parts.

4. Rated Voltage—Along with education of operators and supervisors, the rule should be rated voltage at the terminals of all machines, since less than rated voltage inevitably results in an increase in machine breakdowns, with attendant loss of time and increase in parts consumption.

5. Protection—Moisture in cement, coal dust in an open container of oil, and a bundle of roof bolts thrown along the rib and covered with loose coal are all examples of loss through failure to protect materials and supplies. The moral is enclosed storage for materials or parts subject to weather or water damage, enclosed containers for lubricants all along the line from receipt to point of use, and specific places for everything in the supply line—for example, special supply delivery points, with cabinets, chests and the like as necessary in every section for receiving and storing parts and materials. Indiscriminate dumping inevitably results in loss.

Salvage

The extent of salvage operations depends upon the value of the part or item in relation to the cost of getting it out and, if necessary, reconditioning it. Expending $2 of labor to recover something worth only $1 in the first place is, of course, out of the question. However, in view of the cost of materials and supplies these days, a carefully considered salvage program can result in major savings.

Education is a major ingredient in an effective salvage operation. In other words, if men are encouraged to form the habit of picking up anything they see lying around and turning it in to a specific salvage station—on each section, for example—rather than walking by or, even worse, pitching things into the gob without thinking, the company benefits not only by the return of usable parts and materials but also from the scrap value of worn out items. Of course, each foreman should check on loose and misplaced materials constantly.

Certain items lend themselves to the use of organized salvage crews—for example, crossbar and post recovery. Equipped with mobile pulling units involving wire lines, chain slings and winches, such crews can, where safety considerations permit, recover several times their wages in posts and bars—as well as ties, rails and so on. A few mines have even used mine-detector-type equipment to find carbon-dioxide coal-breaking shells, steel ties and like buried in loose coal or gob in working places.

A new trend which shows signs of growing is the formation of special salvage organizations. As an example, one company appointed an experienced mine superintendent as head of salvage, provided him with facilities at a worked-out mine and gave him final authority as to whether a piece of equipment or a part should be rebuilt or finally junked. It expects a substantial saving per ton over the hit-or-miss program previously in force.

SAFETY EDUCATION, a continuous process, keeps the need for good work habits uppermost in the minds of the men. In this instance, a portal safety meeting is being conducted for crews about to go underground.

The Safety Guidebook

Safety Organization . . . . p 186

Training and Education . . p 187

Maintaining Physical Plant . . . . . p 188

Keeping Interest Alive . . p 193

MAXIMUM SAFETY and high efficiency are inseparable hallmarks of good coal mining. Efficiency follows where safety is stressed, but neither safety nor efficiency prevail where this emphasis is lacking. The safety impetus must come from truly-professional management, sincerely backing safety from the top levels. The beneficial results of such diligent safety promotion will be (1) increased well-being for the industry's employees, (2) increased stature for the industry in the eyes of the public, (3) immediate reductions in cost through lower compensation premiums and other direct savings, (4) improved industrial relations and (5) lower labor turnover.

Safety, like other matters of concern to management, lends itself to a planned approach. The steps in planning are as follows:

1. Organize for safety, employing all available skills to the fullest degree and enlisting all interested parties.
2. Train and educate for safety, using planned programs for workmen, supervisors and management.
3. Maintain the physical features of the mine and its surroundings in the approved manner to eliminate conditions leading to accidents.
4. Keep interest alive by a continuous program of safety incentives, any of which may be scrapped without remorse the minute it loses its appeal.

Safety Organization

Provide an adequate staff in the safety department, and don't dump unrelated responsibilities on safety officials and these staff members.

Include union safety committeemen in consultation on safety matters.

THE TYPE of organization depends upon the job to be done. Within the company there are a number of functions to be performed. Someone must head up the program, someone must inspect the workings, the ventilation system must be patrolled, training must be conducted, and so on. If the company is small all these responsibilities may be handled by one man. In larger companies operating a number of deep and strip mines and cleaning plants the safety department may include one or more qualified men to fulfill each of the functions.

The important requirement is that some provision be made for handling each function, and this is another top-management exercise in bringing together the skills available within the official family and the jobs to be done. The staff of the company safety department should be neither too large nor too small. An overweighted safety department may be-

SAFETY TRAINING, in terminal courses, provides concentrated information on mining hazards and how to avoid them to particular occupation groups.

come a "dumping ground" for a number of other activities for which a natural home cannot be found in other company departments. The result is a loss of enthusiasm for safety work.

The understaffed safety department, on the other hand, may miss too many good bets in safety because of difficulty in maintaining proper coverage of its legitimate responsibilities. The best way to get the proper manpower, in quantity and quality, is through sincere top-management consideration of the matter. A top-notch safety department is worth the effort because it pays off in better employee and public relations, reduced labor turnover and increased efficiency, in addition to its primary function of accident prevention.

Employee safety committees should be included in the table of organization. Their recommendations concerning hazards should be heeded and acted upon, their suggestions should be carefully weighed, and their active support in training and promotion ventures should be solicited.

An excellent example of how such cooperation pays off appears in *Coal Age*, March, 1957, beginning on p 64. The result was that a large mine was able to complete a full year without having a lost-time injury or fatality caused by roof falls.

Above the company level a need may exist for an organization to promote safety for a group of mines or companies having similar safety problems. A full description of an organization of this type appears in the September, 1955, issue of *Coal Age*, beginning on p 58 and featuring the highly successful operations of the Indiana Joint Committee for Coal Mine Safety.

Wholehearted support of local safety associations and institutes by the company and participation of company safety officials in the affairs of Holmes councils and chapters, the National Mine Rescue Association and National Safety Council, for example, are proper extensions of top-management's interest in safety. These, too, represent organization for safety. Of course, cooperation with federal and state safety and inspection authorities is an integral part of any safety effort.

Training and Education

Promote continuous safety education to keep the subject alive in the minds of all employees.

Conduct target-centered training programs to improve safety in specific phases of mining.

THE TERMS training and education are not synonymous. They are two distinct functions, differing in scope and in emphasis. Safety education is a broad program designed to convince workmen and supervisors of the waste inherent in a high accident rate, and of the real values in high safety performance. Safety training, on the other hand, usually takes the form of a hard-hitting direct attack on particular hazards, like 100% training in accident prevention. Safety education is a continuous process, while safety training, on any particular subject, begins, proceeds and concludes in a scheduled well-planned manner.

The educational mission can be carried out through the use of a company publication (if thoughtfully prepared), a well-planned poster campaign, word-of-mouth advice and management example. The safety display board near the lamphouse or at the entrance to the property can be a big help here. If it can't be kept timely, however, and if it isn't kept reasonably clean and in good repair, it might better be removed.

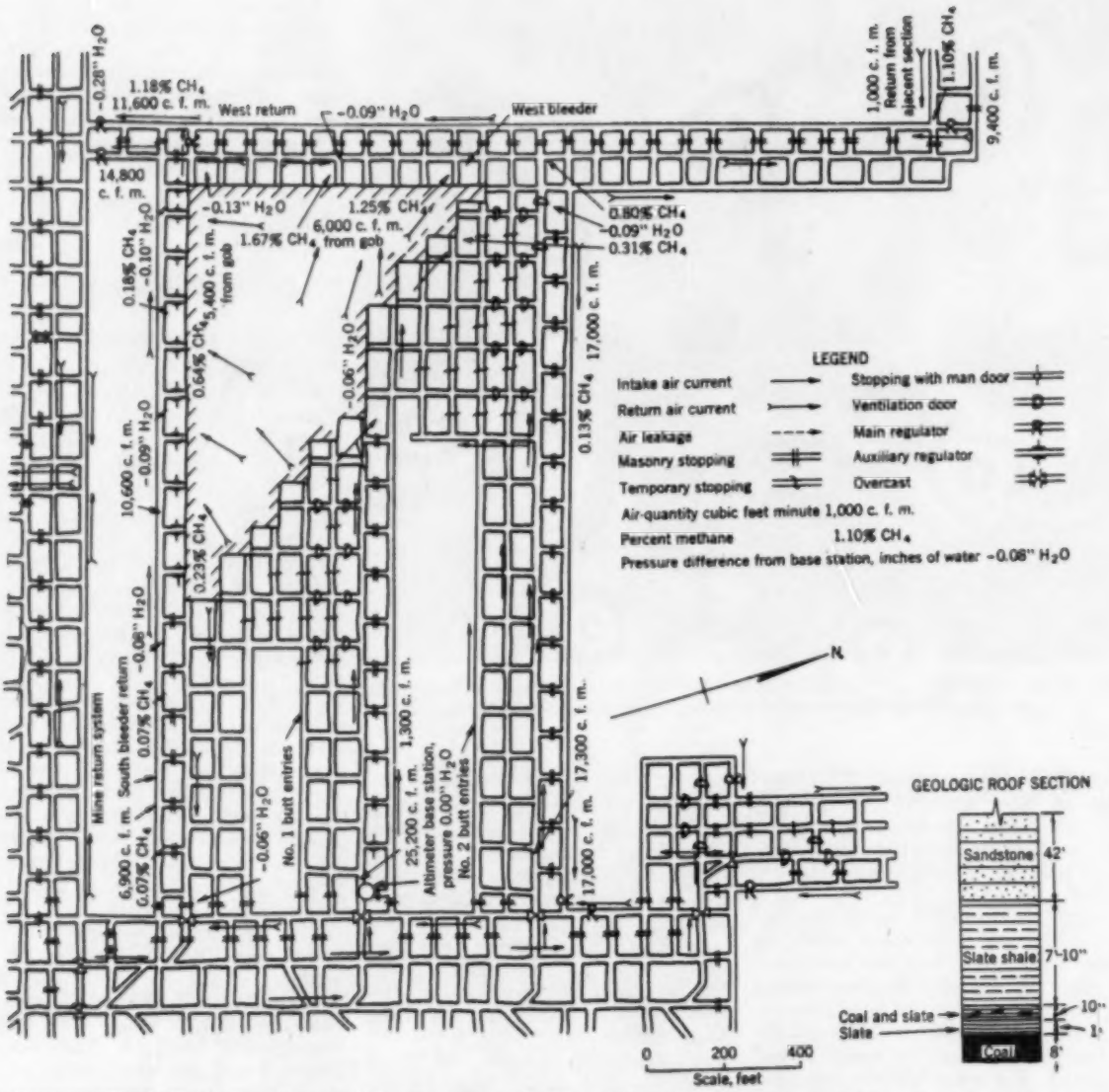
Trend Markers—Safety

National campaign to effect a 50% reduction in roof-fall injuries is opening gun in cooperative assult on No. 1 Killer in coal mines.

Development of approved mine-lighting systems should improve safety performance by raising underground illumination to levels approaching those prevailing in other industries.

Inertial type dust collectors are now being studied in order to determine best ways to apply the units in continuous-mining systems.

Changes in mining codes indicate a return to auxiliary fans with continuous miners under carefully-controlled conditions in some states.



BLEEDER SYSTEMS, above and on the opposite page, make it possible to have positive ventilation of gob areas to prevent sudden outbursts of gas. Major safety benefit is that worked out areas may be periodically inspected.

Training Fundamentals

A need for training may be indicated by a general rise in frequency or severity rates. Or the number of injuries chargeable to a single cause—haulage, for example—may spurt upward. Next step is to select the training material, basing the selection upon the recognized needs of those to be trained. If an outside agency is to conduct the training, these instructors and company representatives should meet to examine the content to make certain it fills local needs.

Course material should be severely limited to the interests and needs of the trainees. In a course for cleaning-plant personnel, very little reference need be made to the fact that roof falls and haulage are the major causes of accidents in the industry. They are more concerned with safety on stairs and ladders, and with such other matters as falls of person, open machinery, dust hazards and electric shock.

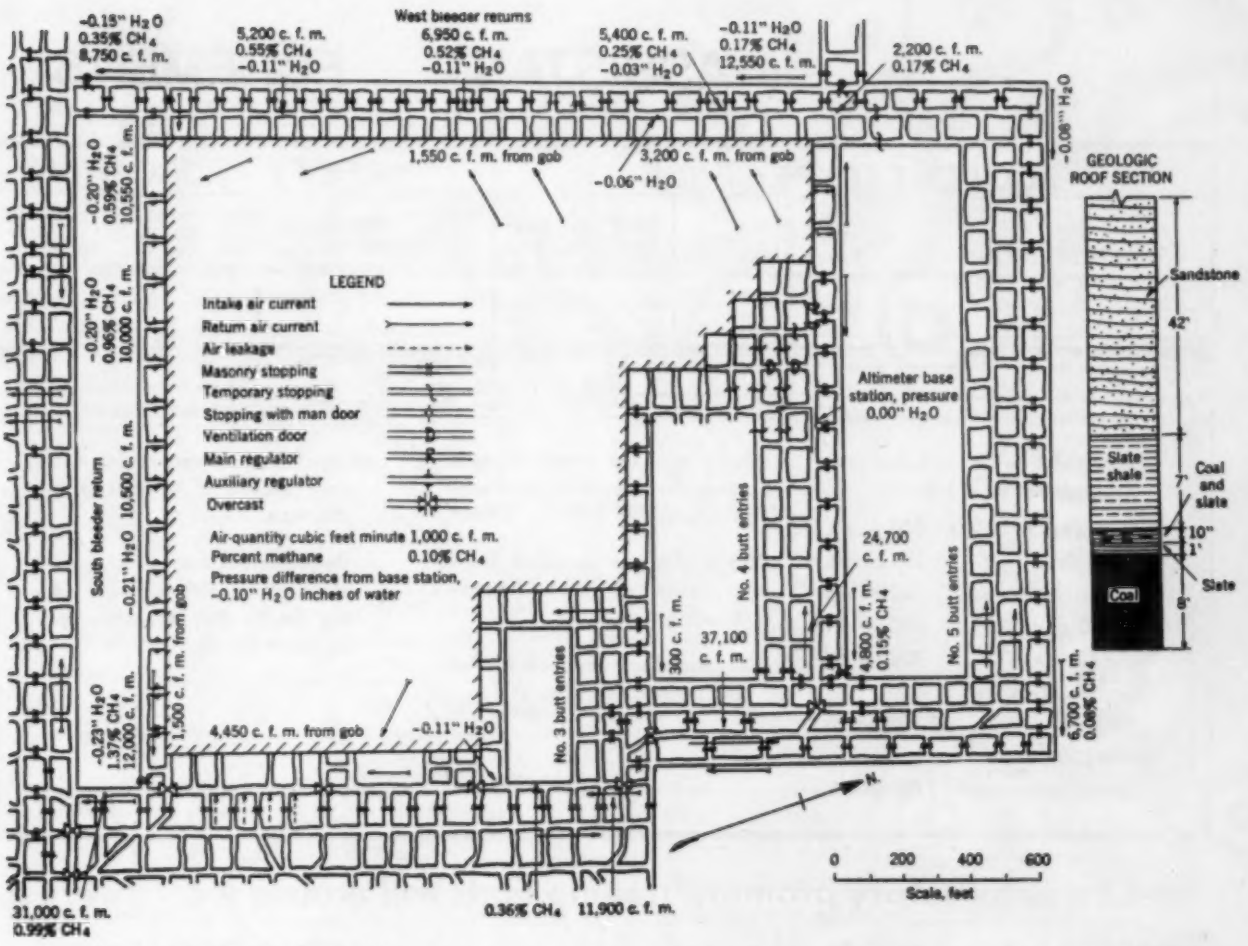
The problem of getting men to attend the training sessions can be a tough one. The safety committee can be of great help here, if the committee has been consulted early in the planning stages. In striving for 100% attendance at accident-prevention training sessions, conducted by Bureau of Mines instructors, company officials will achieve maximum results by working closely with district officials.

Beyond this basic training area there is advanced training work any company may profitably pursue. Periodic training in advanced first aid and mine rescue may be offered to selected men and supervisors. One important goal of this training should be the development of new instructors.

Training, though, is not an end in itself. The clincher is in management's follow-through.

Maintaining Physical Plant

Set up standard procedures to guide safety and production officials in cor-



GREATER SAFETY for underground personnel depends upon good plant maintenance in all parts of the mine. Ventilation surveys, made by competent officials, may turn up unsuspected shortcomings for immediate correction.

recting hazards discovered during inspections.

Stress the need for a good cleanup at the face to prevent dust accumulations

VIGILANCE is the keyword in maintaining a mine, cleaning plant or strip pit in safe condition. A sluggish track switch in the mine, "soft" brakes on a strip-mine haulage truck, dust accumulations in the preparation plant—all these are examples of potential accidents that can be headed off by good plant maintenance. In this connection, the plant includes all real estate, above and below, and equipment.

The steps through which this safety maintenance is achieved are the old standbys — inspection, reporting, repairing and following through. It is to be noted here that all technical and operating departments have a safety function, inasmuch as each is responsible for some degree of inspection and repairing within its own area.

Some larger companies, employing full-time safety inspectors, have set up hard-and-fast rules on clearing up hazardous conditions. The inspector at the end of his visit leaves at the mine or plant a list of the hazards and violations of good practice he has found. Copies of this list are filed in the safety department and with the operations chief. Mine officials are required to take appropriate action to remedy the condition, then report their actions through proper channels to the chief of operations. If such a report does not come up within a specified time, the safety department and chief of operations begin to ask questions. The system insures follow-through on safety-department recommendations.

Deep Mines

The most important elements in maintaining a deep mine in safe condition are roof support, methane control and dust suppression. Falls of roof, rib and face still are the No. 1 killer, although a striking improvement under bolted roof is now in the records. The most promising remedies are closer supervision, strict compliance with timbering standards and bolting patterns, including as much extra support beyond the standard pattern as necessary, and better trimming of overhanging brows and loose coal. These are the only possible solutions to the problem as long as men are needed at the face.

Efficient ventilation is safe ventilation. Proper methane control demands that sufficient air at reasonable velocity be moved past active faces to dilute and sweep away the gases issuing from the coal. Maintenance of physical plant in the interest of safety demands that bleeders, if they are part of the mining plan, be kept open, that stoppings be sealed against leakage and that

ASSISTANT FOREMEN'S

FROM _____ TO _____

ACCIDENT EXPERIENCE					SAFETY EDUCATION				
ASSISTANT FOREMAN	MAN HOURS WORKED	LOST TIME ACCIDENTS	DAYS LOST	ACCIDENT DISCOUNT	GENERAL SAFETY MEETINGS	FOREMEN'S MEETINGS	SECTION SAFETY MEETINGS	SAFETY RULE IN-STRUCTION	CREDITS

Discount charge for each lost-time accident will be as follows:

1 to 7 days lost time	300 points
8 to 30 days	350 points
31 to 60 days	400 points
61 to 90 days	500 points
91 to 181 days	700 points
Over 180 days lost time	1,000 points
Fatality or total disability	2,000 points

200 credits are awarded for attendance at each general safety meeting.

200 credits are awarded for attendance at each foremen's meeting.

200 credits are awarded for holding section safety meeting.

10 credits are awarded for each daily record of safety-rule instruction.

Discounts will be made for substandard conditions found during the monthly inspection (see Discount Sheet).

In-Company safety promotion campaigns will arouse local interest

ACTIVE PARTICIPATION in the current national campaign aimed at reducing roof-fall accidents by 50% in the year ending June 30, 1958, provides an opportunity for each mine to compete against its own past record.

RATINGS

19____

STANDING	TOTAL CREDITS	DISCOUNTS FOR SUBSTANDARD CONDITIONS	TOTAL DISCOUNTS	FINAL CREDITS	STANDING

EFFECTIVE SAFETY INCENTIVES include not only tangible things, like turkeys, gloves and trips but also regular posting of safety inspection reports and foremen's safety ratings.

SAFETY INSPECTOR'S REPORT

Date_____ Section No._____ Location_____

Foreman_____ No. of Places Inspected_____

Substandard Conditions Noted

	Discounts	No. Violations	Total Discounts		Discounts	No. Violations	Total Discounts
Failure to use goggles	40			Man-trip rules (No.____)	35		
Failure to use respirator or dust collector	40			Improper riding on trips or locomotive	45		
Coal dust accumulation	40			Obstruction of clearance	40		
Disorderly lunch station	35			Failure to examine and test roof	50		
Failure to maintain first-aid equipment	40			Failure to set safety post	55		
Inspection and dating of working places	40			Substandard timbering or bolting	55		
Rock dust beyond 40' limit	40			Safety posts improperly set	35		
Improper storage of explosives	40			Guards not in place	40		
Improper blasting with Airdox	40			Failure to cut off master switch	45		
Airdox line and power cable in contact	40			Unguarded trolley wire	40		
Place worked ahead of air	50			Ungrounded electrical equipment	45		
Door left open	50			Improper fusing	40		
Locking device not in place	45			Unfused trailing cable	40		
Crossing cutter bar	35			Improper cable connections to track	40		
Other violations listed below:				Defective cable splices	40		
				Other violations listed below:			

REMARKS:

AIR MEASUREMENTS			
Location	Area	Velocity	Volume

TOTAL DISCOUNTS_____

Inspector

Foreman

MINE FACILITIES should include emergency equipment in a proper state of readiness for emergencies.

BETTER ILLUMINATION promises increased safety in face areas.

SPECIAL PURPOSE UNITS, like this rockdusting car, may be made at the mine.

airway obstructions be removed. Effective gas detectors also must be considered as safety maintenance tools.

In underground dust suppression the big guns are rock dust and water sprays. The latter may include wetting agents. Recent developments in rock-dusting machinery now permit in-cycle distribution.

Wet rock dusting is the latest application method. Goals are not only a good dusting job but also elimination of the dust problem, which can be particularly acute in dusting in cycle behind a continuous miner. Methods and equipment in two mines are outlined in articles in the following issues: *Coal Age*, February, 1955, p 82; January, 1956, p 62.

Whatever the methods, however, the main point is that the rock dust should be evenly distributed, in back headings and returns as well as in more active places. Rock-dust barriers may be included in the overall plan, and the importance of loading out excessive accumulations of coal dust should not be overlooked.

Knocking dust down as it is made by water sprays takes on added importance not only as a means of reducing the explosion hazard but also because of the increased disposition on the part of compensation commissions to grant awards for purported lung damage, even though coal dust still is to be proven as the culprit. For the latest on the question of coal's possible role in lung trouble, see the July, 1956, issue of *Coal Age*, p 56. In any event, prudent management will do its best to keep dust counts below the accepted minimum and supply dust masks when working in high concentrations cannot be avoided.

In all instances, maintenance of a safe plant requires the establishment of fire-fighting systems, including water lines, tested firehoses and chemical extinguishers, where needed. First-aid supplies should be provided in clean, well-lighted rooms.

Stripping

In stripping, safety maintenance is primarily a matter of equipment maintenance. A schedule for wire-rope changes should be worked out, since each unexpected rope failure is a potential accident. Haulage trucks must be kept in good condition to head off steering and brake failures particularly. Well-drained smooth-surfaced roads may eliminate dangerous skids, and in dry weather road surfaces should be sprinkled.

Truck spotters must be properly trained to stay out of the way of backing trucks and out of close clearances around dump ramps. They should also be competent in keeping drivers out of trouble.

Preparation

In preparation plants, particular check points for safety inspectors are dust accumulations on beams, housekeeping in the oil-storage area, clean-up precautions before any welding is done, open gearing, exposed wiring, overhead obstructions and so on.

The possibility of using paints of different colors in the plant might be weighed. For example, standard colors for safety include red for fire exit signs and fire equipment; orange on the inside of movable machinery guards and exposed edges of pulleys, gears, rollers and so on; yellow for handrails, top and bottom steps and caution signs; green for first-aid equipment; and black and white for traffic lanes and direction signs.

One final requirement, if all this

EFFECTIVE FIRE CONTROL, a matter of ever-increasing concern, requires the best in equipment, informed workmen who will attack a fire upon discovery and good management organization to back up and extend the efforts of the men.

maintenance is to be meaningful, is that workmen wear proper articles of protective clothing and refrain from wearing loose clothing.

Keeping Interest Alive

Don't cling too long to incentives that do not work.

Good incentives, the kind that promote team spirit, need not cost a lot of money.

ILL-ADVISED INCENTIVES may not set back the cause of safety but they can be a waste of time for the safety department. A decision to adopt or reject a proposed incentive must be based upon thorough study, with local conditions and personalities weighing heavily in the final judging.

Strange as it may seem, safety bonuses for supervisors have not been an unqualified success in all quarters. The privilege of wearing a white safety hat for supervising a crew through an accident-free month may be more exciting. And even more worthwhile is some scheme where everyone participates in making a good record and shares in the acclaim.

A case in point is the experience at two mines where the supervisor and each workman on an accident-free crew receive a pair of green-colored all-leather work gloves trimmed in yellow each month the record is maintained. Simple, but effective! Frequency rates at the two mines during 1954, the first full year of incentive operation, were 48 and 50%, respectively, below the rates for 1952. An immediate improvement was noted when the program was adopted in August, 1953 (*Coal Age*, June, 1955, p 65).

Slogan contests are effective attention getters, if properly conducted. Application blanks may be distributed as payroll inserts. The response will be gratifying if the prize is worthwhile. Then interest and participation in the next contest will be assured if the winning slogan is widely promoted. One company, for example, has distributed winning slogans on bumper cards for employees' automobiles and displayed them on the shovel dipper sticks and in other places about the properties.

Once an incentive has been adopted it must be given a fair chance to succeed. But if it still fails to have the desired effect in creating enthusiasm or reducing accident rates, it must be summarily discarded. Permitting such an incentive to drag on with only half-hearted promotion may be mighty damaging to the entire safety program. Best practice in a situation like this is to have another idea ready to take the place of the incentive you must scrap, although the new idea should be one that has a better-than-even chance of success.

Timely scheduling of refresher training sessions is another way of keeping safety interest at a high level. The accident-prevention training offered by the Bureau of Mines is practically a "must" at all mines because it has captured the interest of the men at mines where it has been given already. Follow-up sessions on this type of training are especially recommended to insure that maximum long-time benefits accrue.

One of the best ways to keep the safety program alive is to look for opportunities to reward individual achievements in safety. The recipients will be happy to have their achievements recognized, and the others will have their interest aroused. Notable individual safety records may be searched out at virtually every mine.

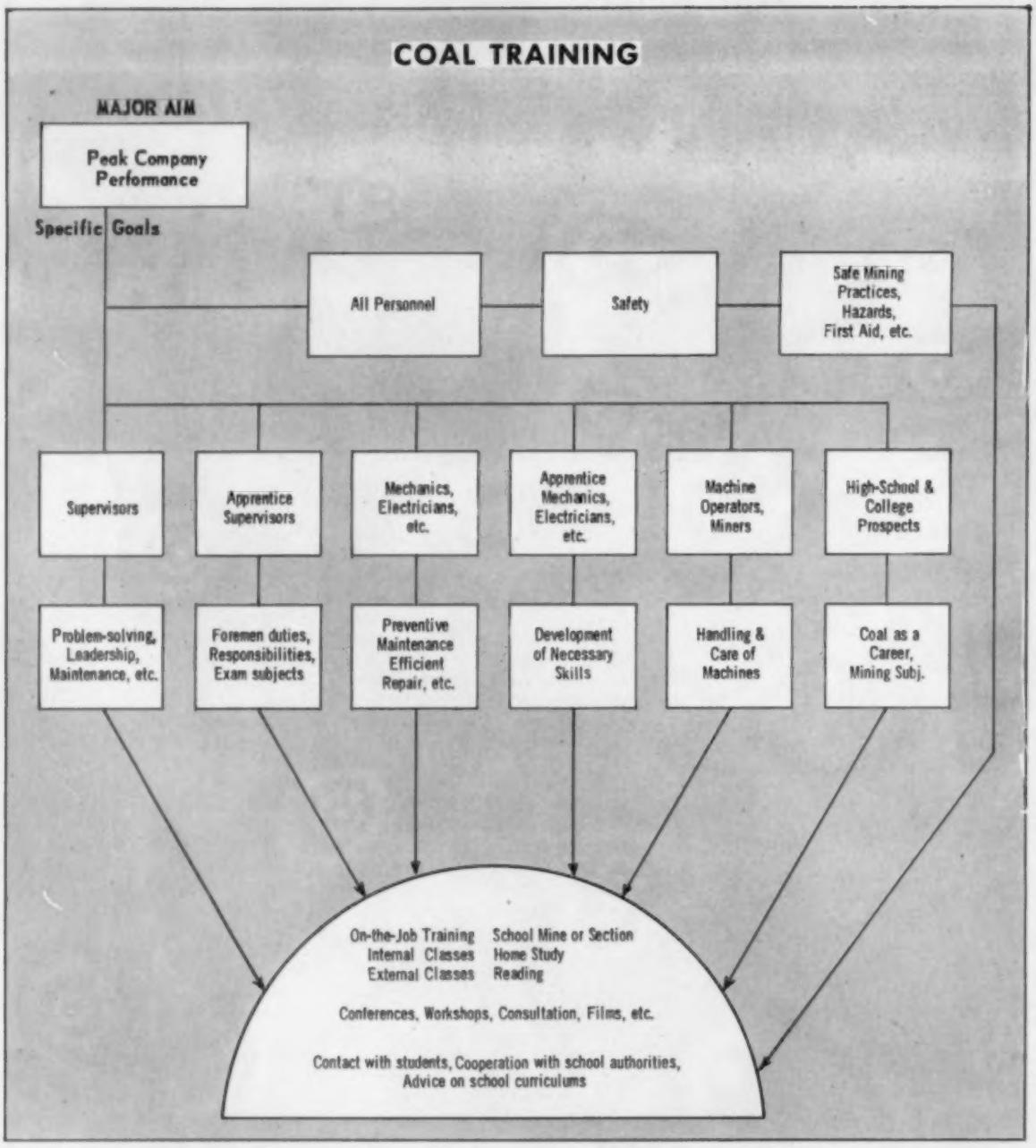
Case Finder—Safety

Eliminating Roof-Fall Accidents—Six-step program permits full year of operation, for an output of 1,427,000 tons, without a single roof-fall injury. *Coal Age*, March, 1957, p 64.

The Bishop Explosion—How it happened, with recommendations to prevent repetition. *Coal Age*, May, 1957, p 96.

Fire Control—Equipment, organization and training are the elements required for effective fire-fighting. *Coal Age*, July, 1957, p 66.

Dust Control With Continuous Mining—What the problems are, what is being done to meet them and what is needed for future progress. *Coal Age*, July, 1956, p 56.



The Training Guidebook

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Trend-Markers—Training

Increasing emphasis being placed on training miners to equip themselves to become foremen.

Skills of existing foremen being increased by courses in being a better boss, in other phases of mining, including maintenance.

Growing need for skilled mechanics and electricians being met by more on-the-job training.

Training of machine operators in skills needed in their jobs and in maintenance receiving increased attention.

Future Possibilities

School mines or sections for training machine operators and other employees for an area or a group of mines.

Wide-scale programs aimed at interesting high-school students in mining to get not only engineers but also miners and supervisors.

safety instruction for ALL company personnel, from the manager in the office to the man at the face.

However impressive safety training progress has been, these cold, hard facts remain:

1. Coal still has the poorest accident record of any major industry.

2. The industry-wide record for lost-time accidents per million manhours has dropped substantially over recent years, but the fatality rate has shown more of a tendency to level off than to improve.

The levelling-off in the number of fatalities suggests that further improvements in this record may be harder to come by. And, besides better mine engineering and more rigid enforcement of regulations, this can mean only one thing: more intensive and extensive safety training effort.

Needed Most—Whether it be safety or job training, the way coal is developing puts a premium on higher skills, which in turn emphasizes the value of training. Taking for granted that a man will pick up all he has to know as he goes along is not adequate to present-day and future needs. If a man is to gain top rating in job performance he must be shown how to do his job quickly, correctly, economically and safely.

With the need for training is a parallel need for a new approach to the questions of recruiting and pre-employment screening. The new approach includes more emphasis on "aptitude tests for screening job candidates," and on the "importance of attitudes and human relations in job performance." It also includes penetrating deeper to school grades.

Management is moving on its training needs and responsibilities. But example, may involve an outlay of some $250,000. Thus, the spread of such systems to more mines, and the development of higher-capacity mining machines, faster haulage lines and improved processing equipment will be meaningless without an adequate, competent force to supervise and operate for maximum output and maintain for a minimum of downtime.

Safety Basic—Greater stress on safety training will also be a basic element in gearing the total production force to higher output per man. The critical importance of protecting human lives is, of course, the paramount issue. Secondarily, however, along with strikes, there can be no greater menace to maximum mine output than disastrous roof falls, explosions or other accidents which cause partial or complete disruption of production for extended periods of time.

Furthermore, as mechanization spreads, the menace of accidents becomes more ominous, especially at the face where new roof-support and machine handling-problems, arising out of continuous-mining techniques, render accident prevention a more difficult job.

Management's increasing recognition of the key role of safety in the production cycle has brought good progress in safety training. Such progress has been realized through the organization of a growing number of company safety committees, Holmes Safety Association chapters, safety meets, and classes in first-aid, fire prevention and mine rescue.

Particularly notable has been the USBM's 100% safety training course which has brought a new dimension to accident prevention by formalizing

RAISING THE QUALITY of the mine operating force—both management and men—looms up increasingly as a major need in coal mining. The big and immediate reason is the necessity for getting the maximum returns from the higher investments in both manpower and equipment to preserve the industry's competition position against the continued pressure of substitutes.

A second compelling reason for major emphasis on increasing the skills of the total production force, and for increasing the number of men in certain categories, is meeting the increased demand for coal that will face the industry in the near future—over 600 million tons of bituminous in 1960, for example. Not only is there a need for more skill in mining and management now, but increased output will require more supervisors, engineers, general inside men and preparation men, as well as many more men for equipment maintenance.

One authority, on the basis of an expected 300-million ton jump in output by 1975, estimates personnel needs as follows:

	1955	1975
Supervision, engineering and office	20,000	22,700
General outside labor	6,000	6,500
Preparation	12,000	14,000
Machinery maintenance	26,000	49,000
Haulage	11,000	10,000
General inside men	38,000	41,600
Production men	100,000	38,200
TOTAL	213,000	213,000

The size of the total production force will remain the same although it will be turning out 300 million tons more of coal. This means that the quality or competence of added personnel, as well as of the sharply reduced face group, will have to be of the highest order. In other words, each man will have to be carefully trained to do his job correctly, quickly, economically and safely then as well as now.

Keeping the total production force down to about its present size is vital if coal is going to maintain its competitive position and realize its fullest market growth potentials. Since labor and transportation costs, in all probability, will continue to rise, the only sure way of holding prices down is through higher output per man. In turn, this will come as a result of increased mechanization and greater manpower efficiency.

Keeping the total production force down to about its present size is also essential because of the heavy investment required for mechanization. One continuous miner with a suitable haulage system and other auxiliaries, for

there is still a long ways to go. And remember: "It's later than you think." The entire training effort must be sped up and expanded if coal is to win its highly promising future. Some of the mechanics for realizing this progress will be described below.

Types of Training

Check over the entire production force to determine what types of training are needed.

Consider the value of training for both specific and general occupational needs.

IN EVALUATING TRAINING NEEDS, a company can consider giving its personnel the following types of instruction:

1. **All company personnel**—General safety training. This can help greatly to increase individual safety consciousness and to promote safe mining practices. Certain personnel, furthermore, might receive specialized instruction to suit occupational needs. The underground man, for example, has the greatest need for detailed information on the dangers of inadequate roof support. Similarly, the tippleman needs special coaching on the hazards of preparation plant machinery and equipment.

2. **Mechanics and electricians**—Instruction in preventive maintenance procedures, how to spot equipment troubles quickly, and how to make repairs efficiently.

3. **Machine operators and selected alternates**—Training in how to handle and care for their machines to ensure maximum performance in the production cycle.

4. **Apprentice supervisors**—Instruction in the foreman's duties and responsibilities, and in all mining subjects he must know how to certify for foreman's papers. Trainees should be carefully selected for leadership qualities.

5. **Apprentice mechanics, electricians and shop workers**—Training in the reconditioning and rebuilding of equipment. Recruits can be drawn from company ranks or from outside sources.

6. **Supervisors and managers**—General instruction in how to be better bosses, and special instruction in how to increase their knowledge and skills in certain areas of responsibility. Foremen well trained in spotting equipment troubles and in good preventive maintenance, for example, can contribute much to minimizing downtime.

Success Keys

Organize the training course or program and get competent instructors.

Create a training environment that will encourage employee participation in training programs.

CERTAIN COMMON DENOMINATORS are basic to the success of any training effort. These are:

1. **Define the objectives of training** and make these publicly known to the maximum number of eligible participants.

2. **Conduct a careful screening of candidates** for new jobs and higher-ranking jobs. Screening is usually based on personal interviews, recommendations from those closely associated with the applicant, aptitude tests, or some combination of these.

3. **Organize and outline the training.** Only the most competent instructors should be used, whether in classrooms or on the job. They should be well versed not only in their subjects but also capable in the art of communication. Instruction can be drawn from a number of sources including company personnel, mining extension services, appropriate state departments, and federal agencies.

4. **Provide adequate, comfortable facilities for classroom instruction,** where included in a training program, as well as authoritative textbook material and illustrative training aids. Equipment, machines and apparatus should be made available for practical application of classroom study.

5. **Create a training environment** that will encourage employee participation in training programs. Salaries for working personnel, for example, should not suffer. Transportation problems should be worked out as much as possible. The company's interest in employee self-improvement should be constantly publicized.

6. **Arrange for periodic follow-up of trainee performance on the job** and make refresher courses or opportunities available to those who want to brush up.

Methods of Training

Use methods best suited to miner training needs.

Give supervisory personnel opportunities to improve their knowledge and skills.

HOW MINERS AND MANAGEMENT PERSONNEL are trained depends generally on company training philosophy, the number to be trained, the type of training and who is to be trained. Those methods generally employed, or most desirable, for training miners include the following:

1. **On-the-job mine or shop training.** At least some exposure to this type of training is virtually indispensable for apprentice supervisors, apprentice mechanics and electricians, and machine operators.

2. **Classroom instruction and extension courses.** Where only one, two or a few men are involved, the mining school extension course is frequently the best expedient.

3. **Combined classroom instruction and on-the-job training.** Some companies find that textbook learning must be accompanied with practical experience for best results.

4. **A school mine or section** serving a field or a group of company mines. This method is specially good for training new employees, transfers, etc.

For training supervisors and managers, the following techniques are considered good practice:

1. **Regular conferences and meetings,** including reports from standing or special committees. Free discussion of problems and other matters of mutual interest open the way to increasing the individual supervisor's or manager's knowledge and skill.

2. **Formal instruction courses.** These may be presented in strictly textbook and/or discussion form, or can be accompanied by laboratory work as, for example, the study of controller panels, etc.

3. **Home study and reading.** Keeping abreast of current developments in the industry and of good mining practices as, for example, through through regular reading of *Coal Age,* is an avenue of learning dependent only on the individual's initiative.

Foremen Training

Seek to develop new supervisors from the ranks through a program combining classroom instruction and practical experience.

Improve the performance of foremen on the job by giving them regular opportunities to discuss their problems with other foremen and superintendents.

THE FOREMAN is still the key man on the production team. As the link between top management and the men at the face, the foreman's abilities to supervise the operation of machines, to handle his men, and to carry out

company standards in mining practice and safety set the stage for the output of a production unit or mine. For maximum effectiveness, the foreman should not only be able to do all the jobs of the men under him, but also know how to instruct them in necessary skills and to inspire them to above-average performance.

The training of foremen usually breaks down into two main parts: training experienced foremen to do a better job, and training men from the ranks on the foreman's duties and responsibilities.

Developing New Foremen — Recruiting and developing new foremen has always been important to replace old timers who are up for replacement. Now and in coming years, however, developing new foremen will take on added importance. The push to higher production will create needs for more supervisors to staff expanded or new properties. It will also demand higher-quality supervision to achieve lowest possible mining costs.

"Imports" of good foremen are becoming scarcer and, furthermore, experience shows that this method is not a reliable means for procuring topnotch career men. Perhaps the best bet for adding to the supply of quality foremen is by upgrading men from the ranks through a combined process of classroom instruction and on-the-job training.

A number of variations of this technique may be employed, especially as these variations deal with the relative amount of time devoted to classroom work and to on-the-job training. One company figures on a 3-mo course which dovetails 600 hr of on-the-job visual education with 75 hr of textbook learning, discussion and home study.

By rotating foremen trainees for 2-wk stretches of on-the-job training in six different mines over a 3-mo period, each man is able to (1) gain first-hand knowledge of a wide variety of seam conditions and mining systems and (2) observe 30 to 40 different foremen on duty. In this way trainees can see for themselves what makes a really good foreman tick. Comparisons are readily made, for example, as to which foremen get the best response from their men and which take the most pains in good housekeeping. Perhaps most important, trainees note:

1. That the mine or section foreman is the key to high productivity.

2. That the foreman's attitude—whether aggressive or lackadaisical—is reflected throughout the ranks of his men.

3. That many mining problems stem from lack of understanding between the foreman and his men.

4. That a good foreman must be able not only to handle men but also to get along with them.

5. That to be successful, a foreman must be a true leader—not only well-informed on the art of mining, but also well-versed in the limits of his authority, and well-practiced in how to be fair and when to be firm to all his men.

On-the-job training should be supplemented with at least 1 hr of classroom instruction per day. It may be necessary to set up two classes to accommodate both day and night shifts. Instruction, given by company or outside experts, or both, should cover all subjects basic to foreman certification. A full curriculum, for example, might include ventilation, gases, approvals and permits, records, general mining practices, explosives, belts and conveyors, electricity, first aid, roof-bolting, general safety, lamp assembly, gas testing and anemometer use. Special instruction on the supervisor's duties, on company standards, and on the importance of human relations in job performance is highly desirable.

Textbook instruction can be based on the state mine foreman's guide (if one is available), or on publications of state mining departments and extension services of mining schools. Such material is usually most effective if adapted and simplified by company instructors.

Upgrading Experienced Foremen—Foremen on the job can get valuable training through conference discussion of their problems with other foremen and with superintendents. The conference method brings collective experience to bear on current problems and permits valuable exchange of know-how and ideas.

One of the best ways of implementing this technique is through regular meetings at the mines. Foremen meet with their superintendent in his office, or some other suitable place, for 1 or 2 hr. The meetings can be arranged so that each foreman from each shift manages to attend one conference of every two or three.

At these sessions, the freest possible discussion is encouraged—no holds are barred. In this way, many opportunities are provided for practical schooling not only in operating and labor questions but in mine mathematics, physics and chemistry. Sometimes, foremen are asked to prepare a "laundry list" which promotes discussion on such problems as:

1. How to instill the spirit of cooperation among employees.

2. How to eliminate absenteeism.

3. How to minimize carelessness and "goldbricking."

4. How to recognize desirable characteristics in a satisfactory foreman.

The conference method also finds expression through division- or company-wide meetings. Foremen are taken off the job for 5-day periods and meet in some central geographical spot to participate in an organized conference agenda. Here, the aims are usually broader in scope than at mine meetings. Company activities and policies are discussed and practical help is given in leadership, employee and community relations, efficient conduct of safety, maintenance, production work and product control. An opportunity is provided to meet and get acquainted with top company officials. The program also includes relaxation and entertainment.

For formal instruction to foremen, consider the possibility of giving night classes from September to May. Classes might meet two nights a week from 8 to 10 PM. Subjects covered could include mine engineering and mathematics, public speaking, better reports, techniques of job instruction and conference leadership.

Men from these classes might then be selected for an intensive 2-wk summer course, meeting 6 days a week from 8:30 AM to 4 PM. Successive groups could be selected between June and early September. While they are going to school, foremen should be paid their regular salaries and no charge should be made against their vacation time.

Maintenance Training

Investigate the possibilities of in-company training to enlarge and improve the present force.

Consider how supervisor training can aid in reducing maintenance costs.

NEEDS FOR MECHANICS, electricians and other maintenance men will undoubtedly become more acute than for any other single category on the production team. The table presented earlier shows that these needs will jump 88%, from 26,000 in 1955 to 49,000, in 1975. There is a shortage of good men of this type even today.

Acute needs for maintenance personnel will stem naturally from the drive to reduce mining costs through wider mechanization. More and better machines will be put into service to increase output per man-day. They

will enable sharp cuts in the face labor force. But these major savings in labor costs will only have meaning if the machines replacing the labor can be kept operated with a minimum of downtime.

Substantiating the point, one-third of the bituminous industry reported to *Coal Age* that better maintenance was one of the major bottlenecks that had to be broken if projected increases in output per man-shift were to be realized (September, 1956, p 57).

Improving the Existing Force—Modern practice points to in-company training, based on combined classroom instruction and practical experience, as the best way to upgrade the quality of the existing maintenance staff.

One company, for example, sets up a definite course of instruction, on company time, for an initial group of 18 mechanics in three classes of six men each (*Coal Age*, April, 1957, p 76). Each of the three classes meets twice a week, from 8 AM to 11 AM, in a specially equipped classroom near the surface shop. The course is designed to provide a minimum of 48 hr of instruction and practical exercises in electrical theory and trouble-shooting. Before the program is completed, 36 other mechanics have an opportunity to take the training.

Purpose of the training program is to provide means through which the men presently employed as section and shop mechanics can upgrade themselves to handle the problems of modern machine mining more efficiently. In developing this program, management was inspired by these two facts:

1. Good preventive maintenance and the fastest-possible location and clearance of electrical troubles are absolute necessities.

2. No one can criticize the work of a mechanic if he is not equipped with the proper tools and the training he needs to adequately maintain today's mining machines.

With such considerations in mind, operating officials and maintenance men met to discuss ways and means of improving maintenance. The outgrowth of these meetings was a formal instruction program, sponsored by the extension services of one of the leading university mining schools.

Instruction begins with a review of the fundamentals of electricity, including the relationships in Ohm's law, characteristics of series and parallel circuits, and the proper use of meters and instruments. Basic principles of motor operation and the functions of relays and contactors are thoroughly treated, using actual machine components as instructional aids.

The aim of this instruction in fundamentals is to draw together on common ground the six men in each class, who most likely have diverse aptitudes and experience. From this point, the emphasis is on circuitry trouble-shooting.

Several concessions are made by the company, and by other mechanics not yet in training. The company agrees to have the men attend the school two days a week for the specified hours and then to complete these shifts on their assigned jobs. This means that, while men are enrolled in the course, they must work steady dayshift during the instruction period. The other mechanics, who enter training later, rotate on the second and third shifts to make this schedule possible.

Benefits of the program indicate that maintenance will be improved through increased job knowledge and job interest among the maintenance men. Reductions in downtime, resulting from faster clearance of outages, are expected to return the investment in training within a reasonable period of time. And a valuable by-product of the training may be the discovery of unrealized leadership talent among the maintenance men.

Recruiting New Staff—More frequently than not, the announcement of shop training for apprentices brings a deluge of applications, considerably in excess of job quota needs. Thus, one of the biggest jobs in adding new maintenance men is in the selection of trainees.

Initial screening is usually based on personal interviews with operating and maintenance officials. For further screening, aptitude tests may be employed to determine more scientifically a candidate's intelligence, knowledge and fitness for mechanical or electrical work.

In one 18-mo shop training program, trainees are put to work in the central shop, primarily on the rebuilding and reconditioning of equipment. They work with experienced mechanics and electricians, covering all phases of maintenance work, from the dismantling of equipment to final assembly and testing.

Along with practical shop work, lecture and classroom study is provided. This part of the training program is conducted in a central repair shop classroom which is equipped with a lecture and demonstration table, a large blackboard, and an opaque projector and screen. Through the use of these facilities, the basic fundamentals of lubrication, hydraulics, mechanics and electricity are explained and illustrated. A special effort is made to have the lecture material coincide with shop work. To round off the program, representatives of various manufacturing companies give lectures on the construction and care of machines and equipment.

A shop training program of 18-mo duration naturally involves a great deal of instruction time. This may become quite a problem as the need increases for adding more new mechanics, electricians, etc., to the staff. One solution here is to start new trainees on a staggered system so that older trainees can assist newer ones.

Supervisor Training – Substantial savings in production time and maintenance costs can be achieved if foremen have a better appreciation of the care of mining equipment. Such appreciation can be best achieved by showing them how to spot equipment trouble before a major breakdown occurs. A company should expect foremen to take instruction as an opportunity to learn and become better or more valuable employees.

A typical course might include instruction in the fundamentals of electricity. Such topics could be covered as Ohm's law, wiring and magnetism, AC and DC principles, DC mine circuits and Lenz's law. With this as a foundation, foreman students could pass to applied maintenance procedures—for example, how to read schematic wiring diagrams, and how to trace and isolate trouble in one part of a circuit and then check items in that section.

The benefits of foremen's maintenance training are not always measurable in dollars and cents. They are reflected in other ways. There is better cooperation between foremen and mechanics. Major breakdowns are prevented since equipment is stopped and repaired before it fails completely. When a failure does take place, there is less downtime because the foreman and mechanic work with the wiring diagram and all effort is directed to fixing the machine rather than to "shooting in the dark." A frequent result is that fewer new parts have to be purchased. Although not easily measurable, benefits add up to more production per shift.

Machine-Operator Training

Consider training in the proper handling and care of machines as a basic factor in achieving maximum mine output.

Explore the possibilities of setting up a school mine or section to provide practical experience in the operation of machinery and equipment.

MINERS require a great deal of skill to get top performance from modern coal-mining machines. Thus, adequate training in the handling of continuous miners, shuttle cars, cutting, loading and drilling machines, timbering and roof-bolting machines, etc., becomes a key factor in achieving maximum mine output. Through the proper handling of machines, the operator also plays an important part in preventing abnormal wear and tear which lead to breakdowns and lost production time.

In most cases, machine operators learn their jobs through on-the-job training as helpers to experienced men. Some of the largest machine manufacturers conduct instruction programs on machine operation for customers. Where such training is available, companies should take advantage of it, especially when shifting from conventional to continuous mining machines.

At least one company has found it beneficial to train shuttle-car and cutting-machine operators above ground. A surface course is staked out and chalk-lined to duplicate the turns an operator must make underground. Trainees then practice for 6 or 8 hr periods under the supervision of the mine superintendent or safety director. As a result, machine maneuvering skills are improved and fewer timbers are knocked out.

School Mines—A small training mine or section—serving a field or a group of company mines—is an excellent way to provide practical schooling in machinery operation.

This technique would be particularly helpful in training new employees, transfers, etc. It also may help to cut down the cost of training. Coal produced in the training mine can be marketed, like any other coal, through the sponsoring company or association. With an experienced foreman and one or two experienced assistants, the cost of such coal might not be too much higher than coal from a regular working section. And once on their regular assignments their production and safety performance should result in lowest cost.

Safety Training

Aim to give all company personnel a better understanding of their safety responsibilities to themselves and to their co-workers.

Provide thorough training in the proper handling of machinery, equipment and tools, and in actual and potential job hazards.

BETTER MINE ENGINEERING will continue as a basic attack in the industry's battle to reduce accidents and fatalities. In the past 3 yr, however, the lack of substantial improvement in the industry-wide safety record suggests that further progress will be harder to come by. It could well be that a temporary stalemate has been reached because the industry has come smack up against the most stubborn of all obstacles—the foibles of human nature. When every individual realizes more completely his safety responsibilities to himself and his co-workers the stalemate, in all probability, will break. And better individual understanding means primarily one thing: more intensive and extensive safety training and education.

Basic to such effort are the following guideposts:

1. **Safety training** should be given to all personnel, from the manager in the office right down the line to the man at the face.

2. **Unrelenting effort** should be made by all personnel to observe safe mining practices and to comply with safety laws and regulations.

3. **Good housekeeping** should be practiced at all times—carelessness and messiness are the harbingers of accidents.

4. **Thorough training** should be provided in the proper handling of machinery, equipment and tools.

5. **All personnel should be thoroughly indoctrinated** in the actual and potential hazards of their occupations, and properly equipped with safety gear when necessary.

6. **Horseplay and taking chances** should be outlawed.

7. **More emphasis should be placed on getting cooperation** in good safety practice than on inflicting penalties for breach of good practice.

It is difficult to document what individual companies should do to carry out a vigorous campaign of safety training and education since, in each case, methods should be suited to particular needs. But a number of general practices have evolved which have proven their worth, or have received fairly widespread acceptance. These include:

1. **Setting up a committee** to promote the cause of observing safety laws and regulations and to act as liaison between management and labor in grievance matters.

2. **Posting bulletins, cartoons and other billboard data** at strategic points to arouse safety consciousness on the job.

3. **Instructing foremen to organize weekly meetings** between themselves and their crews for the discussion of current safety problems.

4. **Arranging for USBM instructors** to give their 100% accident prevention training course to all personnel.

5. **Providing instruction** in first-aid and mine-rescue work.

6. **Participating** in safety contests.

7. **Promoting attendance** at Holmes safety chapter meetings.

Worthy of special note is the USBM 100% accident-prevention course. This has added a new dimension to safety training by requiring 100% attendance of company personnel. Experience proves that unless 100% of the officials and men are trained at the mine, improvements in accident reduction are not as good as where the training is 100%. USBM monthly records on man-hour exposure show improvements of 20 to 60% at most mines where the accident-prevention course is given (*Coal Age*, October, 1956, p 88; May, 1955, p 93).

Pre-employment Training

Expand existing recruitment and publicity programs.

Concentrate on high schools for long-range development of new talent.

THE NEED IS URGENT for drastic revision of pre-employment training and recruitment programs if the great demand for new young men in the industry is going to be met. Aside from the unusually large needs for maintenance men cited previously, the industry is already faced with an immediate shortage of 250 engineers (*Coal Age*, March, 1957, p 54).

The dearth of new recruits is largely due to the fact that not enough thought and action has been devoted (1) to publicizing the advantages of a coal-mining career, and (2) to considering high schools and colleges as the main sources for developing a new flow of talent for trained men in mine management *and mine operation*. In the public mind, coal mining is still a risky, unrewarding occupation totally lacking in the glamour and challenge of such industries as aviation, chemicals, petroleum, electronics and atomic energy.

Engineering Recruitment — Essentially, the industry's problems in selling the coal profession to young men can be solved by improving and expanding existing pre-employment and training programs.

Excellent publicity material has been prepared for all levels of stu-

dents by the National Coal Association, other coal associations and some companies. Mailings of such material, however, are dwarfed in comparison to educational programs carried on by other industries.

One of the most promising developments on the recruitment scene is increasing management recognition of the importance of interesting high-school students in coal-mining careers. More and more personnel managers are realizing that the high-school student, particularly in coal-mining areas, is the key to long-range fulfillment of personnel needs. However, although a handful of companies are conducting aggressive high school campaigns, only the surface of opportunity has been scratched.

Some 200 scholarships in mining engineering, for example, are offered throughout the country by coal associations and individual companies. But this number is certainly not adequate when compared to the industry's immediate needs for engineers mentioned above. It becomes even less adequate in view of reports that many existing scholarships go unclaimed.

Much could be done to alleviate the scholarship situation by more wide-spread advertising of scholarships, by sending company and association representatives to recruiting areas to sell the modern coal profession to prospects, and by setting up salary scales and living conditions commensurate with other professions.

When scholarships are awarded for college study, it is frequently desirable to pin the grantee down to a formal contract. By this contract, the company agrees to pay, say, $1,000 per yr for 4 yr of college education. In return, the grantee agrees to work for the sponsoring company for at least 2 yr after graduation.

Salaries offered sometimes can not be as good as those offered by some other industries. But the differential, where occurring, is made up through the benefits of the 4-yr scholarship. Also, by having the grantee agree to work for at least 2 yr with the company, he is brought to the point where he can take the mine foreman's exam, thus qualifying for higher pay. At least one company has had outstanding success in holding scholarship winners through this contract system.

Mine Recruitment—Engineers are one industry need, but miners, mechanics, electricians and bosses are equally critical now and in the future. A well-thought-out and well-carried-out program also serves to build the interest which will make recruitment in these categories more rewarding among high-school and junior high-school students.

There are a number of approaches to developing and holding the interest of such students. A typical approach, however, might capture the interest of boys and their parents in the modern coal mining profession through sponsoring science fairs, movies and lectures about coal, and inspection trips to mines. These efforts might be accompanied by offering aid to organize high school mining curricula and to set up vocational guidance committees. It might also prove expedient to subsidize, or otherwise provide, necessary teaching and guidance talent.

High-school mining courses are generally designed for 3 yr and school time is divided between traditional academic subjects and vocational subjects, with careful correlation to insure that boys will become good citizens as well as good miners. A typical course might be made up as follows:

Sophomore Year, Mining Subjects—Geology of coal, mine law, mine gases, ventilation, timbering. **Shop work**—Welding, bench work, lathe, drill, shaper.

Junior Year, Mining Subjects—Tracks and transportation, ventilation, drainage, pumps and pumping, related mathematics. **Shop Work**—Electrical circuits and diagrams, motors and controls, resistances, testing equipment.

Senior Year, Mining Subjects—Explosives and blasting, ventilation, mine law, mapping and drawing, mine chemistry, applied trigonometry. **Shop work**—Hydraulics, general mechanics (clutch, transmission, gears, power), timbering, tracklaying.

All Three Years—Academic Subjects: English, social studies, physical education.

Teachers forming courses like the above are, for the most part, experienced coal mining men. Realizing that teachers with coal mining experience are essential but scarce, coal operators and associations can cooperate to seek out properly qualified men for teaching jobs.

Help in Buying . . .

A COMPLETE CROSS SECTION of the modern equipment, materials and services offered by manufacturers and service organizations is presented in the following pages to round out this 1957 Mining Guidebook issue of *Coal Age*.

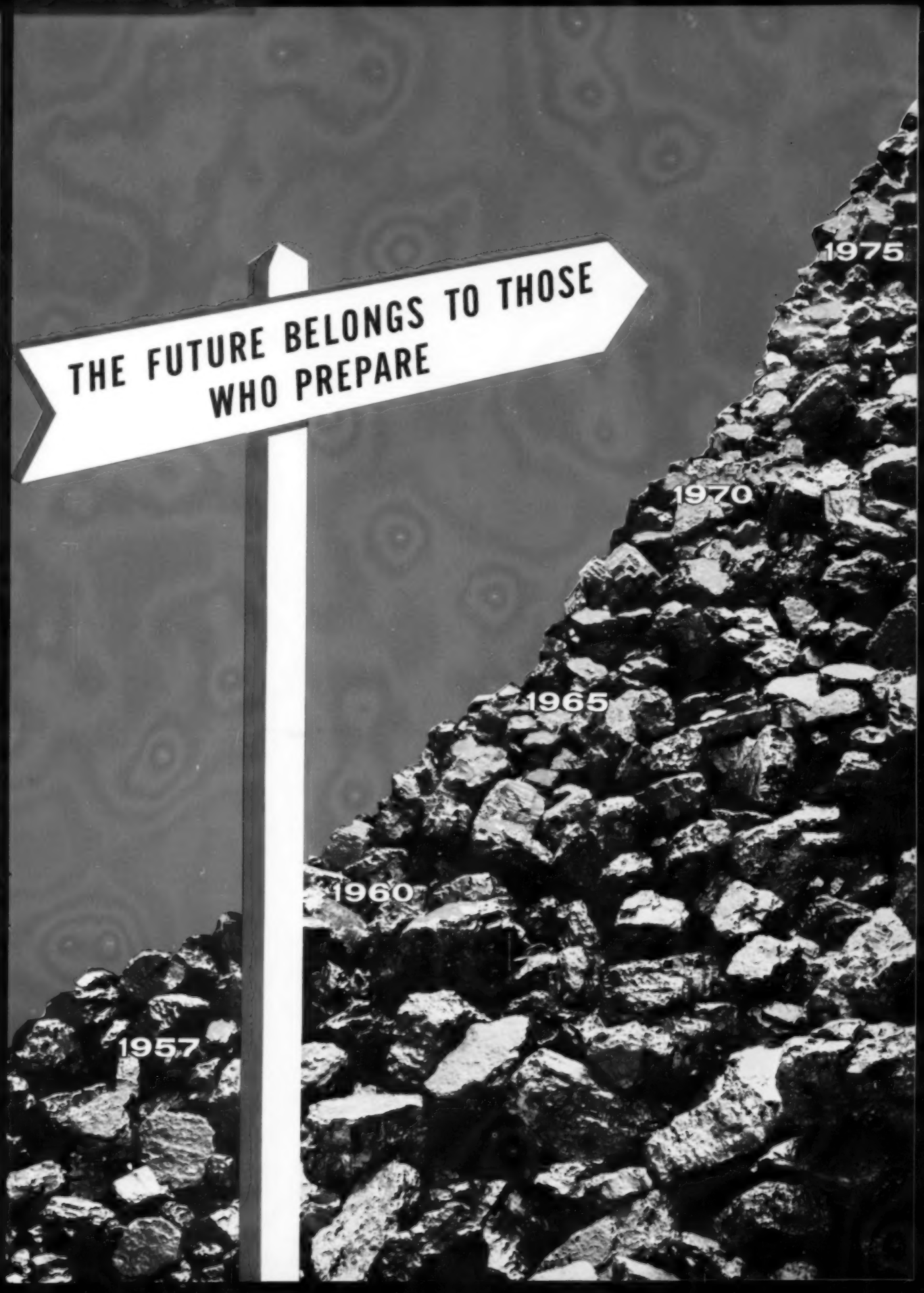
1. If you need equipment, materials and services not previously used . . .

2. If you are interested in additional sources of equipment, materials and services . . .

3. If you are developing a new idea in production, preparation and safety and want to see what's available for carrying it out . . .

Check the Buying Directory beginning on p 289 of this issue. Find the product in the alphabetical list. Under it will appear the names of the key manufacturers, with those advertising in this issue indicated by black-faced type. Trade names also are included in the Buying Directory for convenience in identifying and selecting products.

Consult advertisements in this issue for information on specific products.


THE FUTURE BELONGS TO THOSE WHO PREPARE
1957
1960
1965
1970
1975

What does handling coal FROM THE GROUND UP mean to YOU?

FROM THE GROUND—TO THE CARRIER
From "crude" coal to any desired fuel refinement—large or small—slow or fast—The Men at McNally have the KNOW-HOW—Have Done It —for GREATER PROFITS for McNally Customers

COMPLETE PLANTS—EQUIPMENT—PARTS

McNALLY PITTSBURG

MANUFACTURERS OF EQUIPMENT TO MAKE COAL A BETTER FUEL

McNally Pittsburg Manufacturing Corporation—Manufacturing Plants: Pittsburg, Kansas • Wellston, Ohio
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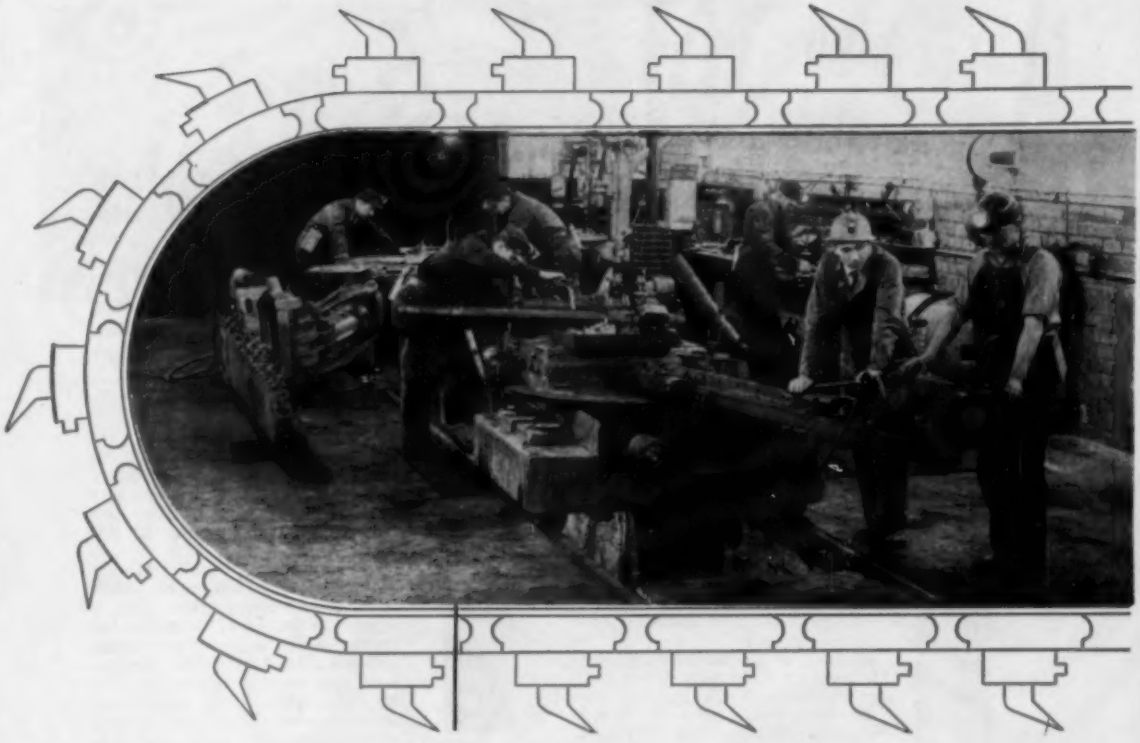
REDUCED MAINTENANCE COST WITH TRACY PARTS



REPAIR PARTS FOR GOODMAN, JEFFREY AND JOY CUTTING AND LOADING MACHINES

Ball Bearings
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Controller Fingers
Controller Parts
Cutter Arms
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Controller Segments
Gears
Pinions
Roller Chain
Rope Drums
Shafts
Sheave Wheels
Sprockets
Worms
Worm Gears

REPAIR PARTS FOR JOY SHUTTLE CARS

Conveyor Parts
Couplings
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Worms

REPAIR PARTS FOR MINE LOCOMOTIVES

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•

CUTTER CHAINS AND DRIVE SPROCKETS FOR GOODMAN, JEFFREY AND JOY CUTTING MACHINES
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ELECTRICAL EQUIPMENT

Armature Shafts
Cable Splicers
Carbon Brushes
Controller Fingers
Controller Segments
Controller Parts

MANUFACTURED BY **BERTRAND P. TRACY CO.** PITTSBURGH, PENNA.

BRANCHES IN HARLAN, KENTUCKY • SMITHERS, WEST VIRGINIA
MILL AND MINE SUPPLY COMPANY, BIRMINGHAM, ALABAMA

6 great Tiger Brand Cables

AMERCLAD
PORTABLE POWER CABLE
types W and G

Amerclad power cable is extremely flexible, and will withstand continual reeling on and off drums. Because of its light weight and great toughness, it is widely used for electric shovels, dredges, cranes, excavating machinery and similar equipment.

Type W is recommended for potentials up to 2000 Volts. It has no shielding or ground wires. Type G is good for 5000 volts. When rated over 2000 volts, the insulated conductors are shielded with PS nonmetallic shielding, and all type G cables contain ground wires.

AMERCLAD
LOCOMOTIVE GATHERING CABLE

This single-conductor cable is especially designed for gathering-reel type electric mine locomotives. Standard conductors are copper, but they can be furnished with steel wire reinforcing for greater tensile strength. Copper conductors, on the other hand, withstand kinking better and they are easier to splice.

The cable is reinforced with tough seine twine and the flame-resistant Amerprene jacket is lead-sheath vulcanized.

AMERCLAD
PORTABLE CORDS
types SO and SJO

These cords are identical except that type SO has a heavier jacket. This cord is extremely flexible and is designed for use with portable tools and appliances. The tough Amerprene jacket is highly resistant to oil, grease and water. Many different types of cord construction are available.

AMERCLAD
TWIN PARALLEL MINING MACHINE CABLE
types W and G

Compared to two-conductor round cables, Twin Parallel Cables occupy less space on a reel or drum, and are lighter in weight. They are recommended for use up to 600 volts.

Amerclad Twin Parallel Mining Machine Cables feature the AS&W "Bridgewall" construction. This is literally a bridge of neoprene between the two insulated conductors and the ground wire. The "Bridgewall" construction enables this cable to withstand crushing weight and severe abrasion without service interruption. This cable also features dynamically balanced, fully engineered rope-lay conductors to insure equal tension.

AMERCLAD
2-CONDUCTOR ROUND MINING CABLE

The color-coded conductors are insulated with a heat-resisting rubber compound, then twisted and covered with a reinforced oil-resistant Amerprene jacket. Interstices between conductors are filled with neoprene.

The jacket is flame-resistant and can withstand tremendous abuse in all kinds of weather.

AMERCLAD
WELDING CABLE

The tremendous number of extremely fine copper wires in this cable provide an unusual degree of flexibility. The cable lies flat without kinking or snarling and there is no undue strain on the operator's wrists. A separator is applied between copper and rubber, so it is easy to strip the insulation to make a splice.

3 great Tigerweld Bonds

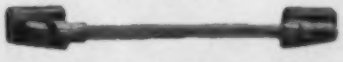
WEDGE-TYPE

The Tigerweld Wedge-Type Bond is primarily designed for quick installation on tracks that may have to be moved, but this durable bond holds so well that many mines use it for permanent installation. It can be installed in a few minutes with a high speed drill and a 3-pound hammer. In spite of its ease of installation, the wedge-type bond holds with a grip that won't shake loose. But if you want to remove the bond from temporary trackage, you can hammer it out as easily as you put it in.

BF-10

The Tigerweld BF-10 has self-clamping terminals to make installation easy. The terminals can be secured to the rails by a few taps of a hammer. And they stay firmly in place while the steel-to-steel weld is made. The BF-10 has great resistance to fatigue stresses. It can be reclaimed and used again and again.

BF-12



The Tigerweld BF-12 Bond is designed for quick, permanent low-resistance installation by welding. Just drive it on the base of the rail and it stays in position ready to weld. No special clamp is necessary. Your maintenance crews can install more bonds per day at lower cost. And once the BF-12 Bonds are installed they're on to *stay!*

All of these bonds are butt-welded. That means that in every case all the wires are electrically connected—permanently—to the solid end piece. Butt-welding will consistently develop almost full strength of the strand on a tensile test to destruction. So always specify Tigerweld Bonds. They're *all* butt-welded!

AMERICAN STEEL & WIRE DIVISION, UNITED STATES STEEL CORPORATION

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SALES OFFICES

BOSTON ..... Statler Building	KANSAS CITY ..... Power & Light Building
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CHICAGO ..... 208 So. La Salle Street	NEW YORK ..... 71 Broadway
CINCINNATI ..... Fifth-Third Bank Building	PHILADELPHIA ..... Suburban Station Building
CLEVELAND ..... Rockefeller Building	PITTSBURGH ..... 525 William Penn Place
DENVER ..... First National Bank Building	ST. LOUIS ..... 1221 Locust Street
DETROIT ..... General Motors Building	ST. PAUL ..... First National Bank Building

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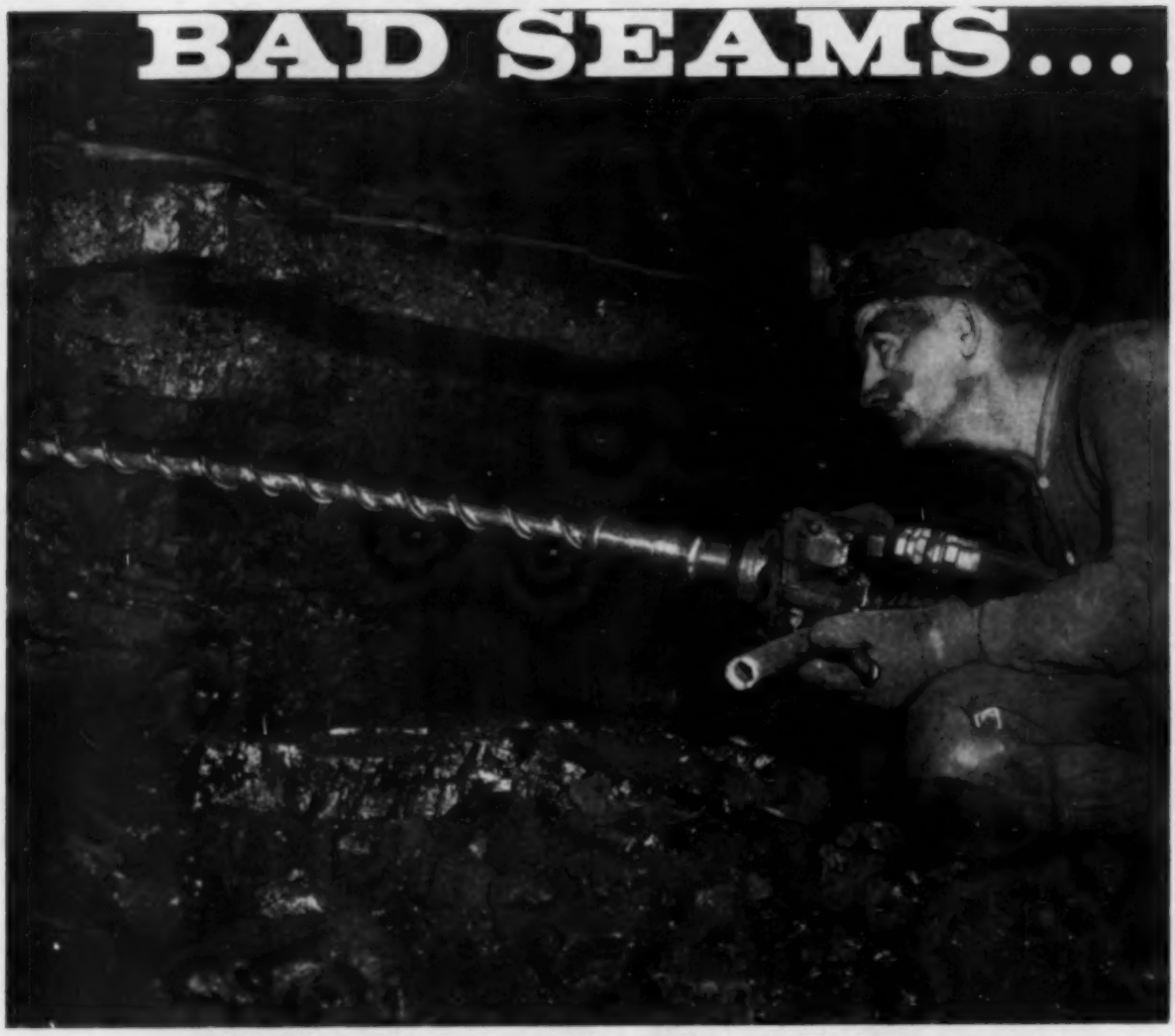
TENNESSEE COAL & IRON DIVISION, Fairfield, Ala., Southern Distributors
UNITED STATES STEEL EXPORT CO., 30 Church St., New York, N. Y., Export Distributors

USS

UNITED STATES STEEL

Gets the best of BAD SEAMS...



CP Hydraulic Coal Drill

Drilling a 9 foot hole every 30 seconds in bad seams is standard for this 35 lb. coal drill. Long auger lengths are easy to handle. Its high torque motor packs the power for hard drilling . . . responds instantly. 1000 RPM auger speed holds vibration to a minimum.

Run the CP-35-HCD from the power system of cutting, timbering or roof bolting machines. Absolutely safe . . . no sparks or shock . . . no kick on stall! For details, write: *Chicago Pneumatic Tool Company, 8 East 44th Street, New York 17, N. Y.*

ACCESSORIES INCLUDE: **Valves, gauges, junction blocks, hoses and fittings**

Chicago Pneumatic *8 East 44th Street, New York 17, N. Y.*

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American Cyanamid... serving you with plants and magazines in major coal-mining areas!

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Another phase of this service is the readiness of American Cyanamid's representatives to give you expert assistance on any unusual blasting problem.

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High Explosives	Electric Blasting Caps
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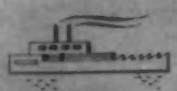
Kleenslot

WEDGE WIRE PREPARATION SCREENS

mining



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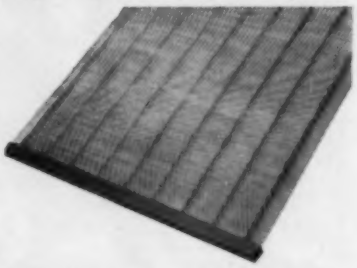
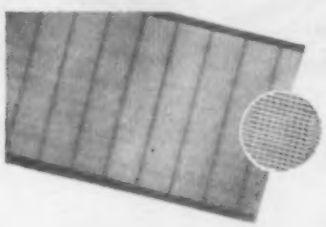
SCREEN GUARDS

A new innovation in the mining and industrial field. Particularly adaptable for use in flumes. The screen guard is built right into the screen and the vertical guard bars keep the larger lumps of material above the guard bars, permitting only the finer particles to pass over the screen. Special sizes can be furnished.



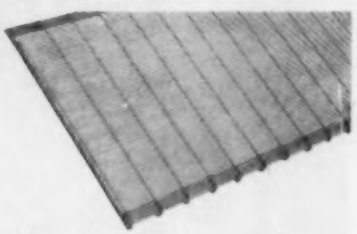
VIBRATOR SCREENS

They can be designed and adapted to fit any make of vibrator. You do not have to change your present machine to accommodate this screen. It is of quality construction and built to give maximum service. The rigid construction and method of installation prevents "whipping".



MARCEL-TYPE SCREENS

This screen is entirely different inasmuch as it is of a Marcel-type construction. It was designed for operations where slivers passing through are objectionable in the end product. This screen can be made in all sizes and shapes wherever applicable to higher and productive efficiencies. It gives long life and non-blinding operation.



ALUMINUM SCREENS

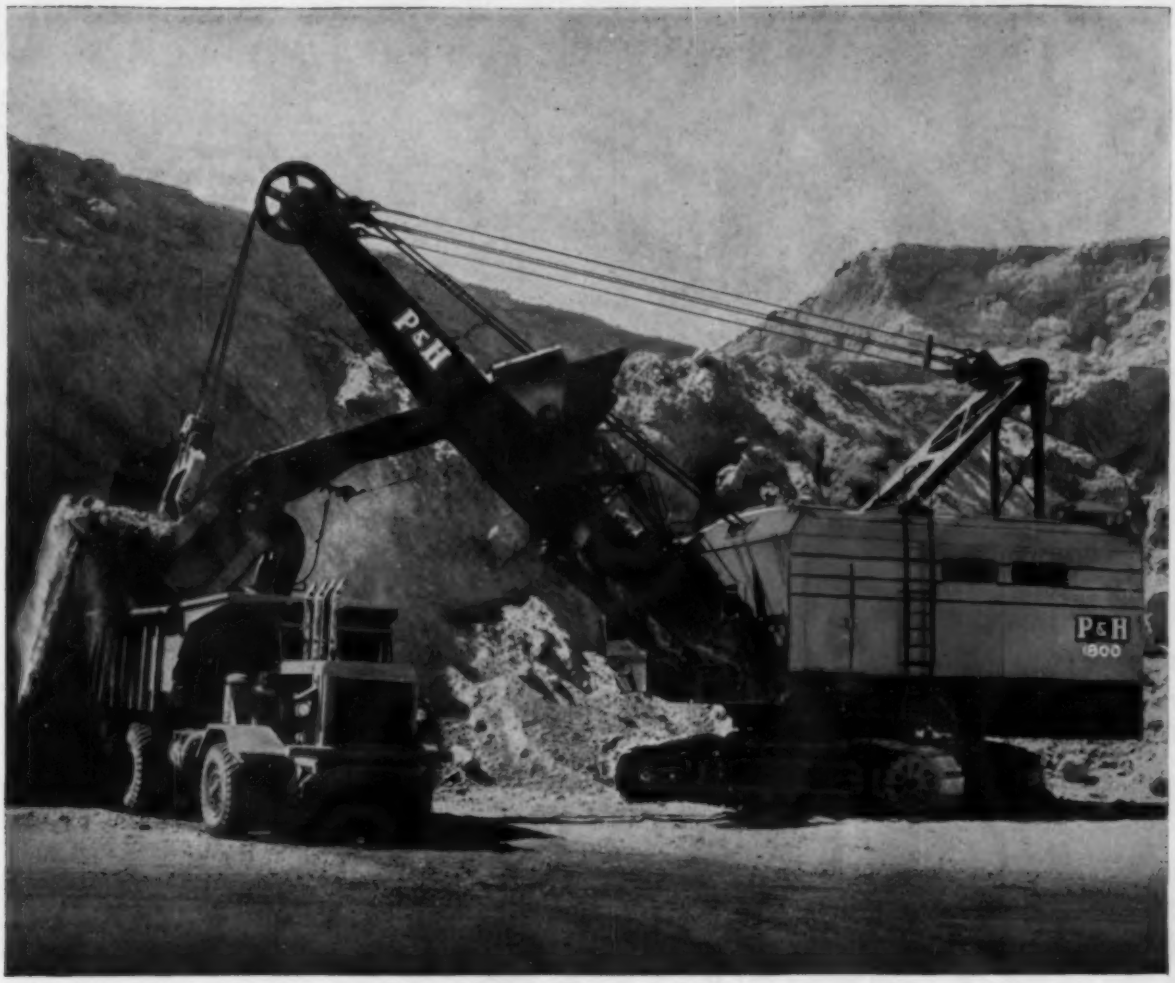
This aluminum screen has all of the attractive and sturdy features of many other metals. In addition, it offers flexing action that adds capacity and dewatering abilities which are almost unbelievable. No changes are necessary in the body of the screen to effect its installation.

NON-BLINDING — NON-CLOGGING – LONGER LIFE – MOST ECONOMICAL

The diagram at left shows all of the efficiency that can be furnished to you by KLEENSLOT Wedge Wire Preparation Screens, inasmuch as the wedge construction permits easy clearing. KLEENSLOT Wedge Wire Screens can be furnished in practically any type of metal. It costs nothing to obtain a Wedge Wire recommendation free of charge. Complete literature is available for the mining, oil, food, chemical and abrasives industry. There is a KLEENSLOT Wedge Wire Screen for every application.

WEDGE-WIRE CORPORATION

GAS STREET AND NICKEL PLATE R. R.
WELLINGTON, OHIO



dig modern . . . cut tonnage costs with

P&H ELECTRIC SHOVELS featuring MAGNETORQUE* and ELECTRONIC CONTROL

In mining operations throughout the world there is good reason for the cost-cutting record of P&H Electric Shovels. Magnetorque plus P&H Electronic Controls give smooth, effortless operation—faster dipper action—heavier bail pull.

P&H Electric Shovels offer many other advantages that mean greater availability and lower maintenance costs, especially under severe conditions. With P&H you get all-welded strength, simplicity of design and proved on-the-job dependability. P&H Electric Shovels range from 3½ to 8 cu. yds. in capacity.

Customer demand for P&H equipment makes it wise to anticipate your *future* needs *today*. It will pay you to contact your P&H dealer soon.

*T.M. of Harnischfeger Corporation for electro-magnetic type coupling.

HARNISCHFEGER

Construction & Mining Division
Milwaukee 46, Wisconsin

HAVE YOUR COAL TEST-CLEANED in the modern R&S Pilot Plant

THIS modern R&S pilot preparation plant lets you take the guess-work out of coal cleaning. Using a full carload sample, with full size equipment, under actual operating conditions, it shows exactly what R&S equipment can do for your coal. At the end of the process all end products are analyzed by an outside, unbiased laboratory—Commercial Testing and Engineering Co. You get their full report in writing, plus the recommendations of R&S coal preparation specialists.

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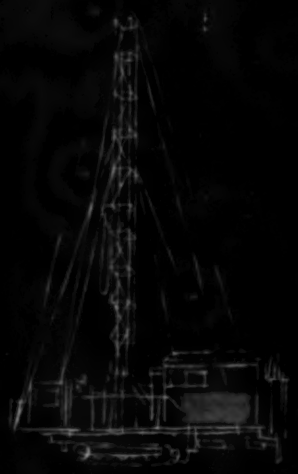
Hibbing, Minn.—P.O. Box 675



THE WORLD'S MOST COMPLETE LINE OF MODERN MINING EQUIPMENT

JOY

PRODUCTS FOR COAL MINING

UNDERGROUND EQUIPMENT

Continuous Mining ..... pages 2, 3
Conventional Mining 4, 5

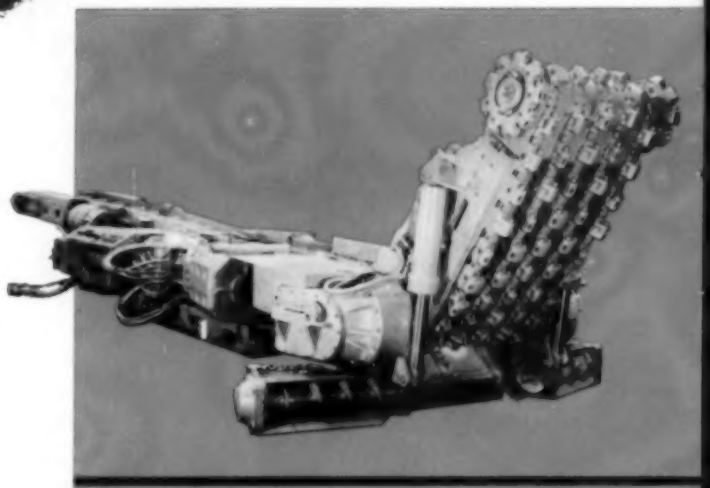
ABOVE GROUND EQUIPMENT

Surface plant equipment ..... page 6
Strip mining and exploration 7
Surface equipment, con't 8

DIRECTORY 8

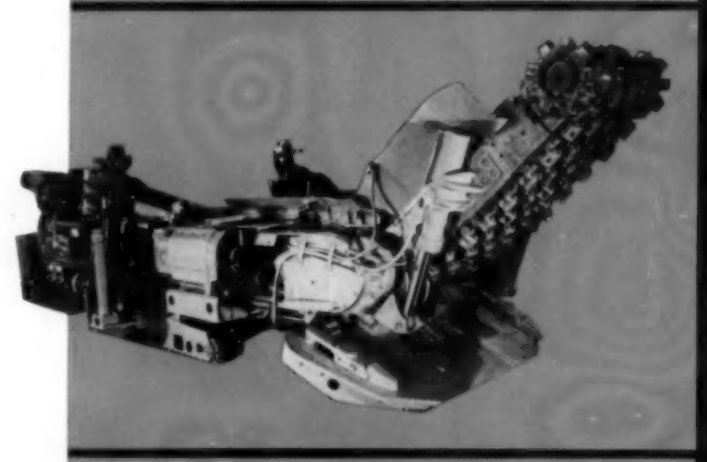
JOY MANUFACTURING COMPANY · HENRY W. OLIVER BLDG. · PITTSBURGH 22, PA.

CONTINUOUS



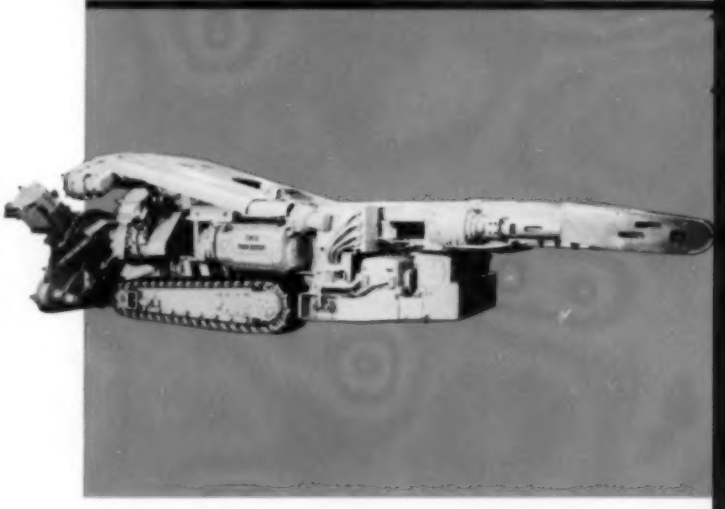
5-CM JOY CONTINUOUS MINER

Only 32″ high for seams 38″ and higher . . . rated capacity is 4 to 5 tons per minute. Has extra-deep sump (24″) and extra-long (5 ft.) ripper head. Mines from 5″ below floor to 82″ above floor. Head is 42″ wide . . . empties into a single, hopperless conveyor. Mines rooms from 12 to 20 feet wide. Total HP, 250; L., 31′; W., 108″ . . . also available with integral roof drills. *Bulletin JC-406*



1CM-3 JOY CONTINUOUS MINER
for medium-high seams

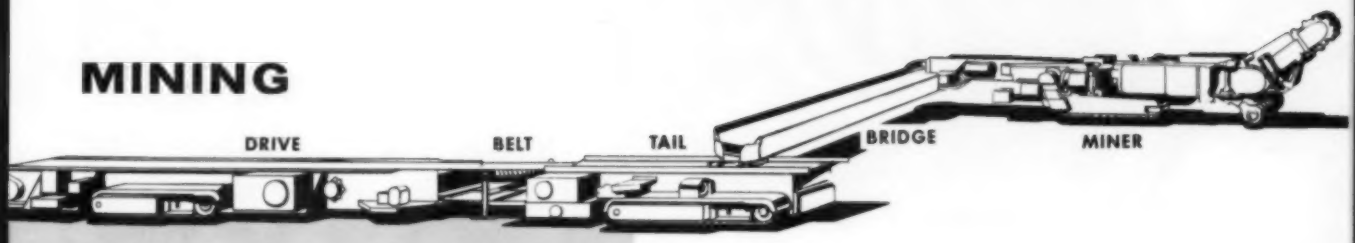
Completely new miner has new gathering arm clean-up . . . same principle as Joy loaders. In 18′ room, cleans up bottom to within 8″ of rib. Only 47″ high . . . mines 4½ tons per minute in seams 60″ and higher. Sumps 21″ deep with 42″ wide head. Cuts from 7″ below floor to 100″ above floor. Mines room 11′ to 21′ Wide. Total HP, 250 . . . 276 with roof drills. L., 30′8″; W., 92″. *Bulletin JC-407*

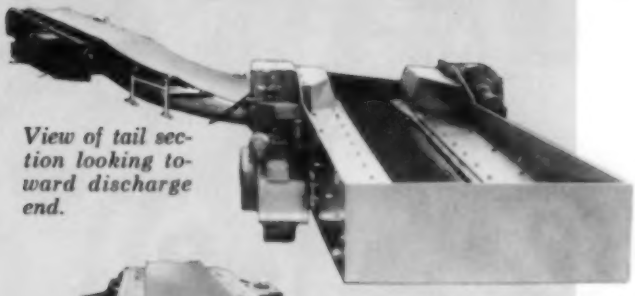


JOY 2BT-2 TWIN BORING MINER

A heavy-duty, high production, full face boring machine. Mines 8 tons per minute in coal 5′11″ to 7′11″ high . . . cuts widths up to 12′8″. Top cutter chain variable 12″ in height while machine is operating. Boring arms collapse for tramming. Wide treads support 78,000 lb. weight with ground pressure of only 24 psi. Total HP, 260. L., 27′; W., 10′3″ to 10′7″. *Bulletin CC-42*

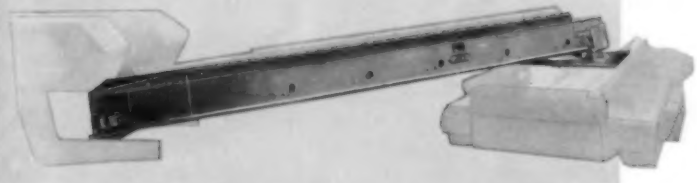
MINING





View of tail section looking toward discharge end.

Drive section — stores the belt, controls tension, drives conveyor.



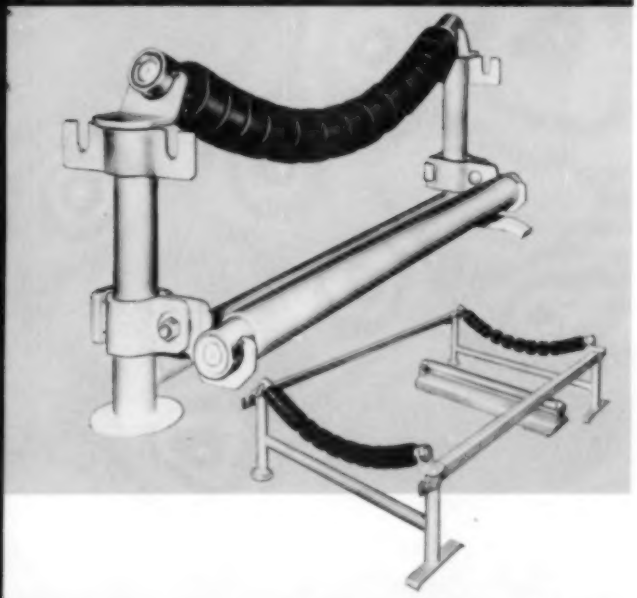
JOY EXTENSIBLE BELT CONVEYOR

Continuous haulage system for continuous miners. Distances up to 1000 ft. Extends or retracts 50 ft. while carrying full load . . . belting stored automatically. New 100 ft. of belting added in 3 to 5 min. Belting between crawler-mounted tail and drive sections supported by Limberoller idler sections. Self-aligning tail pulley keeps belt on pulley even when tail section is 30° off square. Three models available . . . 24″, 30″ and 36″ belt widths. *Bulletin JC-303*

JOY BRIDGE CONVEYOR

for JOY extensible belt conveyor

Connects continuous miner and extensible belt regardless of their positions . . . miner can drive cross cuts. One end suspended from boom on tail of miner . . . other end rides on flexible supports on tail section of ex-belt. Permits 65° swing of miner tail without spillage. L., 15′ to 28′ as required; available in same widths, speeds and ratings as companion extensible belt.



"LIMBEROLLER" BELT CONVEYOR IDLER

Supports belt, forming intermediate section of extensible belt. Idler consists of neoprene discs molded to flexible steel cable. Cable is suspended between two bearings forming natural smooth curve . . . shapes to load . . . yields to load without "bumps." Weighs 1/3 of conventional idlers. Suspended on special stands that hook together without tools.

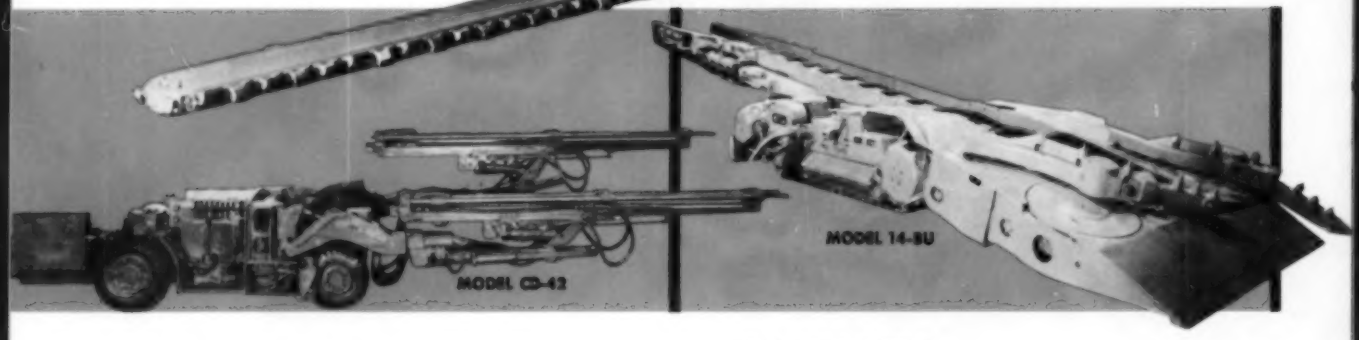
Limberoller idlers and stands available with standard, high and low mounting brackets for use with regular conveyor systems; or special styles for use on any existing conveyor. Widths 24″, 30″ and 36″. *Bulletin LDC-105*

CONVENTIONAL MINING

JOY COAL CUTTERS

Complete line: shortwalls, longwalls; track or rubber-tire mounted Universals. Floor Types: 5-B1 shortwall, 10 HP; 11-B, with automatic bugduster for conveyor mining, 35 or 50 HP; 7-B shortwall with bug-duster, 50 HP; CLE-5 longwall, 50 HP, 12″ high, 28″ cutting width, air or electric drive. Mounted Units: 10-RU trackless universal for thick seams; 11-RU universal, 31″ high, for medium seams; 12-RB or 12-RT rubber-tired top or bottom cutter for thin seams.

MODEL 15-RU


MODEL CD-42

MODEL 14-BU

JOY COAL DRILLS

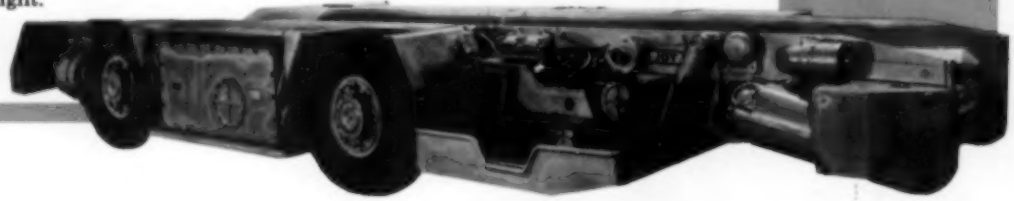
Hydraulic or electric; track or rubber-tired mounting; mountable units. Trackless units: single-boom CD-22 for thin seams, 30″ high; single-boom CD-25 for medium seams; twin-boom CD-26 for wide rooms, 30″ high; single boom CD-41, twin-boom CD-42, with continuous auger feed, 43″ high. Single boom CD-40 easily mounts on 10-RU or 11-RU cutter chassis. *Bulletin CC-46.*

JOY LOADERS

Eight models: 12-BU for conveyor mining, 29″ high, 1½ tpm max. cap.; 8-BU lightweight loader for bad conditions, 3 tpm max. cap.; 20-BU for very low coal, 24″ high, 8 tpm. max. cap.; 14-BU for medium seams, 30½″ or 36″ high, 8 tpm max. cap.; special low seam 14-BU-9 only 26″ high; 11-BU for thick seams, 10 tpm max. cap.; 30-BU for split seam work, 43″ high, 10 tpm; 18-HR-2 and 18-HR-3 for rock or ore loading, 65½″ or 87″ high, 12 tpm.

JOY SHUTTLE CARS

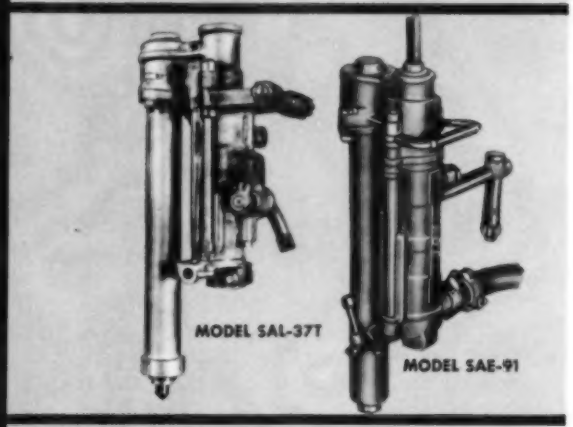
Joy built the very first shuttle cars . . . now has years of field proof and constant design improvements. Available with capacities from 2 to 14 tons and heights from 26″ to 66″; cable reel or battery power. All have disc brakes; power steering, Magnetax Control, specially designed bodies that permit easy access with loader boom and quick interlocking when one unit used as surge car. Most models have 4-wheel drive, 4-wheel steer, 4-wheel brakes, interchangeable wheel units. When requesting additional data, please specify seam height.



MODEL RBD-15

HYDRAULIC ROOF-BOLTING DRILLS

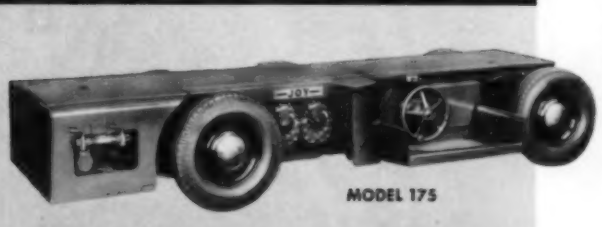
Compact, self-contained, self-propelled units with high maneuverability, great drilling power and unequalled flexibility. Instant adjustment of infinitely variable combinations of thrust, feed speed, rotation speed and torque; thrusts to 5500 pounds at 1050 psi. Single unit RBD-15 turns in its own 114-inch length; is 33″ or 37″ high for seams from 42″ to 96″. Twin-boom RBD-11 uses same drill unit on each 9½-ft. boom; offers 23-ft. drilling range; is 43″ high. *Bulletin CC-50.*


MODEL SAL-37T

MODEL SAE-91

PNEUMATIC ROOF-BOLTING STOPERS

Centralized feed controls, "push-button" rotation release, corrosion-resistant cadmium-plated parts, constant feed and feed pressure throughout the entire extension of the telescopic feed leg. Lightweight telescopic SAL-37T has 18″, 24″, 30″, 36″, 42″ steel change; short-length SAE-91 has 14″ steel change, also available with 18″, 24″, 30″ and 36″ steel changes; SAE-91T has telescopic feed for steel changes 24″ to 48″. Dustless SAE-91T and SAL-37T also available with vacuum type dust collector.


MODEL 175

JOY MINE-AIR COMPRESSORS

Mine-Air Compressors are two-stage units. 15% more efficient than single-stage compression. Air-cooling eliminates cooling water. Force-feed lubrication assures proper lubrication of working parts and minimizes cylinder wear and friction losses.

Complete line: Class WK-82 compressors are drawbar types. Class WK-83 compressors are self-propelled. Each class has four sizes, delivering 130, 175, 240 or 275 C.F.M. at 115 P.S.I. track-mounted or mounted on rubber tires.

JOY BELT CONVEYORS

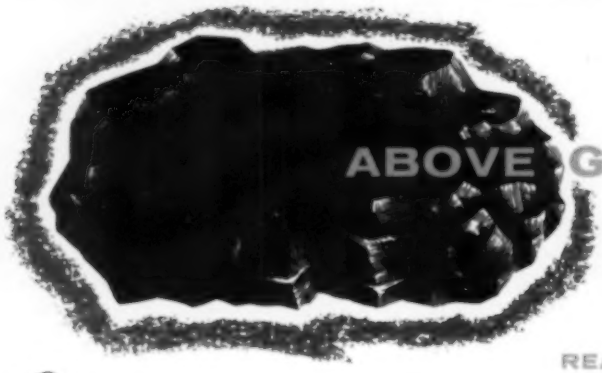
Joy Mine Tandem Belt Drives are specially designed . . . twin drive pulleys (lagged with ½″ vulcanized rubber) are all-welded steel with taper-lock hubs . . . MTB Drives available in widths from 24″ thru 42″ and in HP ratings from 25 thru 150.

Conveyors are available in all belt widths with Limberollers or 3-roll steel idlers, ball bearing or roller-bearing type . . . intermediate sections, single or tandem pulley drives in sizes from 15 to 300 HP.

MTB drive shown with Limberoller Idlers.

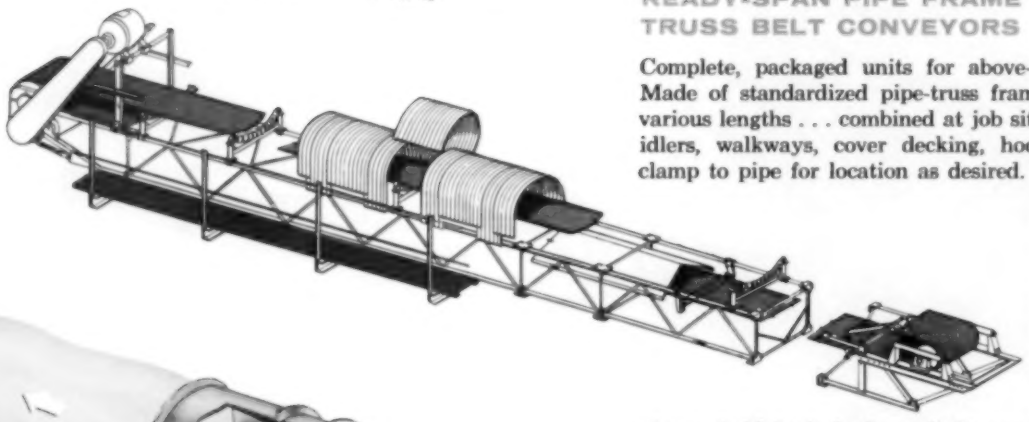
"LIMBEROPE" ROPE BELT CONVEYORS

Consists of two parallel steel wire ropes stretched fairly tight between two anchoring points. Joy Limberoller idlers, in special brackets, are mounted between wire ropes. Support stands are arranged under wire ropes to hold them at proper level. As load comes on belt, ropes "give," resulting in excellent troughing, less spillage. The Limberoller is essential to proper operation of this type of conveyor.



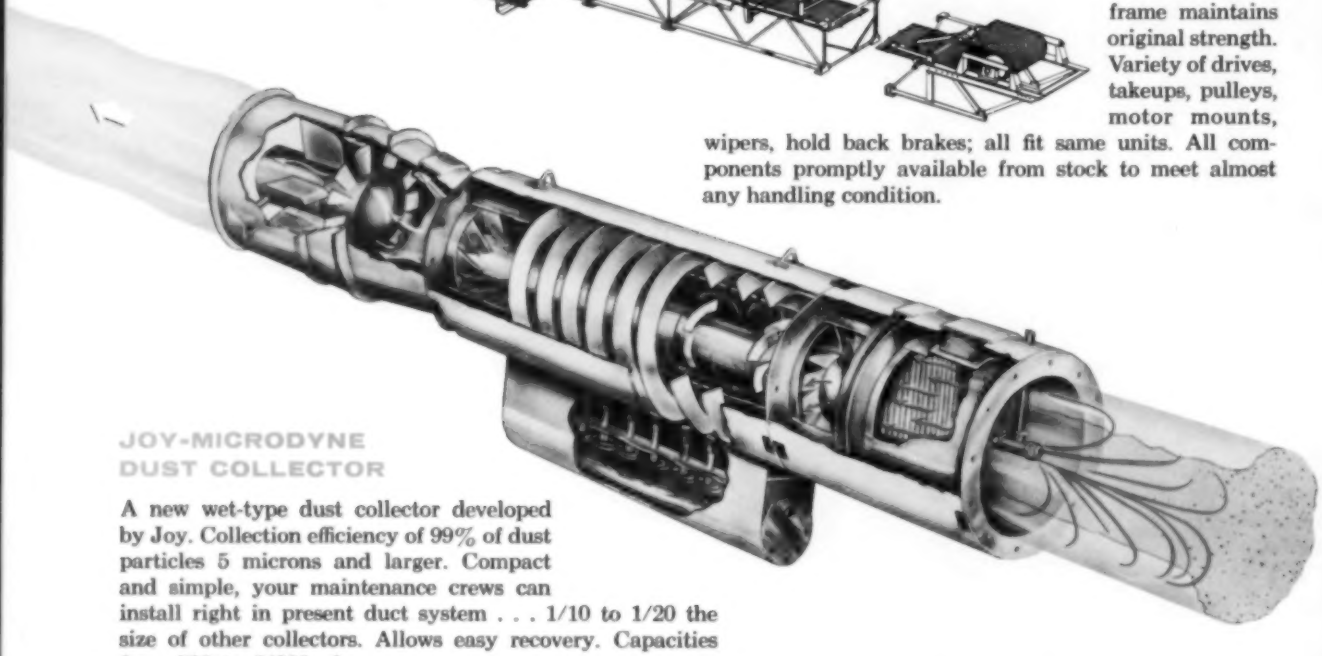
ABOVE GROUND and STRIP MINING EQUIPMENT

READY-SPAN PIPE FRAME TRUSS BELT CONVEYORS



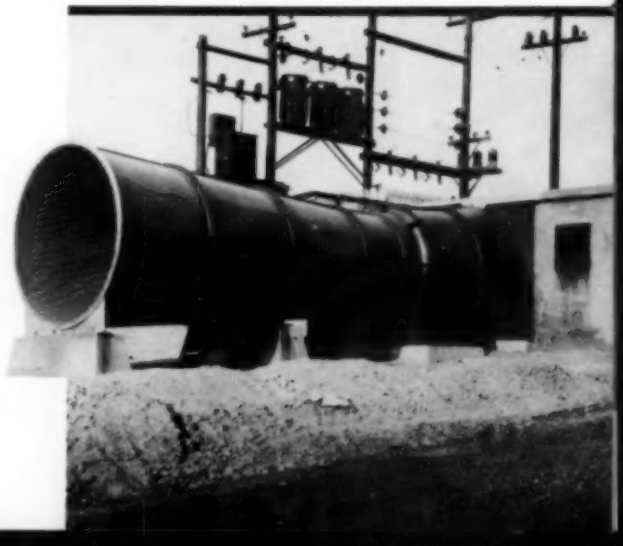
Complete, packaged units for above-ground handling. Made of standardized pipe-truss frames in sections of various lengths . . . combined at job site. All accessories, idlers, walkways, cover decking, hoods and supports clamp to pipe for location as desired. There is no need to burn or drill holes in framing to attach any accessory . . . frame maintains original strength. Variety of drives, takeups, pulleys, motor mounts, wipers, hold back brakes; all fit same units. All components promptly available from stock to meet almost any handling condition.

JOY-MICRODYNE DUST COLLECTOR



A new wet-type dust collector developed by Joy. Collection efficiency of 99% of dust particles 5 microns and larger. Compact and simple, your maintenance crews can install right in present duct system . . . 1/10 to 1/20 the size of other collectors. Allows easy recovery. Capacities from 500 to 64000 cfm.

JOY "AXIVANE" MINE FANS AND BLOWERS



The Joy mine fan has 5 exclusive features: Low operating speed, wide operating range, simultaneous blade adjustment, built-in steel base, readily accessible bearings. Available in two types: High Pressure and Intermediate Pressure. CFM ratings from 9000 cfm to well over 1,000,000 cfm.

Joy Portable blowers are all-purpose units available with electric direct drives, electric V-belt drives, or gasoline engine V-belt drive. Permissible models are available for gaseous mines.

MODEL 59-BH

MODEL 60-BH

MODEL 225

ROTARY BLAST HOLE DRILLS

JOY CHAMPION DRILLS

Champion blast hole drills are rotary air-blast drills, crawler mounted for extreme mobility. Four field-proved models:

56-BH . . . drills holes to 6¼" dia. Weight, 35,000 lbs.

58-BH . . . holes from 6¼" to 7⅜". Weight 46,000 to 50,000 lbs.

59-BH . . . holes to 9" dia. Newest of Champion drills . . . uses round pipe for stable drill string and better air circulation. Wt., 65,000 to 68,000 lbs.

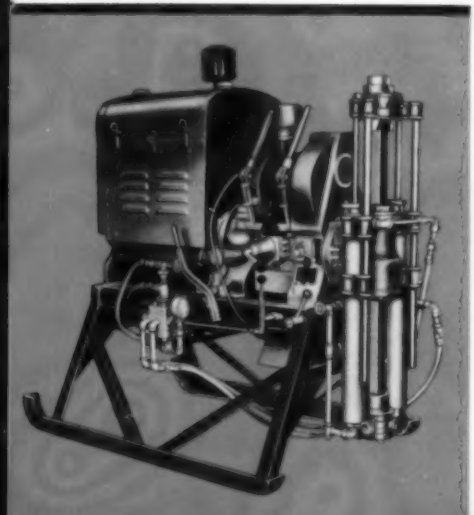
60-BH . . . Largest of the champions . . . drills holes 9" to 12" in any formation. Weight, 85,000 lbs.

All Joy rotary blast hole drills operate on the rotary-air-blast principle . . . Continuous pressure is applied to a roller-cone bit with a continuous blast of compressed air for hole cleaning and bit cooling. This method proves 4 to 5 times faster than churn drill methods.

JOY "BLASTAIR" DRILLS

Extremely mobile, the 225 Blastair is truck mounted. Uses Joy air-blast principle to drill 6¼" dia. holes. Holes are smooth, parallel walled . . . easy and safe to load.

Joy also builds pneumatic drills of the Challenger class with range of 3½" to 4½" to any depths required for strip mining. Challenger Drills are self-propelled, either on rubber tires or crawlers, and mount either the Joy TM-500 or TM-450 pneumatic drill.



JOY DIAMOND CORE DRILLS

Available in a variety of models and sizes, Joy Diamond Core Drills are the ideal drills for proving mineral deposits. Light, medium, and heavy-duty machines, skid-mounted for portability, remove accurate core to depths of 2250 ft. All models are available with gasoline, diesel, or electric drive and with either hydraulic or screw-feed swivelheads.

CORE DRILLING BY CONTRACT. Skilled crews and complete stock of core drills and equipment.

TRUCO DIAMOND BITS. Quality diamonds set for proper clearance in patented, abrasive-resistant, tightly gripping matrix. Available in all standard sizes; special types and sizes for unusual applications; serviced by field engineers.

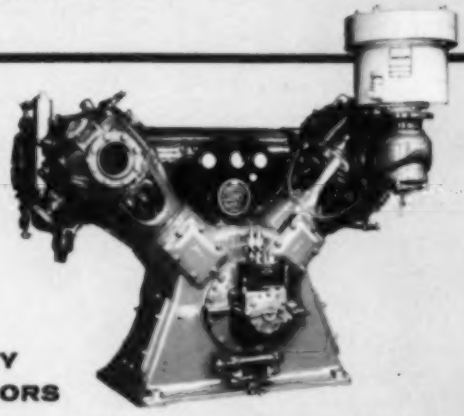
RESETTING SERVICE—prompt, world-wide, efficient. Salvaged and new diamonds combined for best service.

MODEL RP-600

JOY "AIRVANE" PORTABLE COMPRESSORS

A new line of rotary portables includes models with capacities from 125 to 900 cfm. Oil cooling system includes unique Thermal-By Pass for even, fast warm-up. Control system features new "Servair" load control . . . pressure is set just by turning a dial. *Bulletin AC-58*

MODEL WN-112



JOY STATIONARY COMPRESSORS

For the maintenance shop, cleaning plant, or for permanent installations to supply compressed air for all mine requirements, Joy has a complete line of modern stationary compressors with displacements from 1/3 C.F.M. to 6048 C.F.M. They are available both in air-cooled models for intermittent duty, and in double-acting, water-cooled models for heavy-duty, continuous operation.

ELECTRICAL DISTRIBUTION SYSTEMS

The famous Safety Circuit Center for protection against shorts, overloads and ground faults . . . in wide range of AC or DC ratings for underground or above ground.

Also trouble-free Joy plugs and receptacles made of neoprene for shatter-proof, moisture-tight service under any conditions.

Consult a Joy Engineer

. . . ABOUT THESE OTHER JOY PRODUCTS, TOO

Utility hoists, Carpullers, Cutter-Bit Heaters and Sharpeners, Tungsten Carbide Rock Bits, String-a-lite Portable Lighting, Wagon Drills, Coal Borers, Hand-held Rock Drills, Paving Breakers, Rock Loaders, Scraper Loaders, Utility Trucks, Post Pullers, Timber Setters, Bugdusters, Room Hoists, Cable Vulcanizers, Track Switch Throwers, Bit Heaters.

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Colo., Denver 2.....1626 Wazee Street
1626 Wazee Street (Schloss & Shubert)
D. C., Washington 6.....1741 K Street, N.W.
Idaho, Kellogg.....North 1 Division Street
Ill., Centralia.....Fifth and Chestnut
Ill., Chicago.....360 W. Washington Boulevard
Mass., Boston 15.....88 Brookline Avenue
Mich., Detroit.....17615 W. McNichols Road
Minn., Duluth.....1021 E. Superior Street
Mont., Butte.....24 W. Granite Street
Mo., St. Louis 10.....1203 Macklind Avenue
N. Mex., Carlsbad.....507 Park Drive
N. Y., New York 6.....140 Cedar Street
Ohio, Cleveland 11.....16141 Puritas Avenue
Ore., Portland 9.....1631 N. W. Thurman Street
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Ontario, Toronto.....200 King Street, W.
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EXPORT OFFICES

New York, New York 22.....60 East 56th Street

JOY MANUFACTURING COMPANY

GENERAL OFFICES — HENRY W. OLIVER BLDG., PITTSBURGH 22, PA.

The company reserves the right to alter or improve the design or construction of its machinery as described herein and to furnish it, when so altered, without reference to the illustrations or descriptions in this bulletin.

Printed in U.S.A.

BULLETIN M-218 2M—6050-7

NEW

THE FUEL PROCESS M TYPE
COAL WASHER

A NEW EFFICIENT COMPACT WASHER DESIGNED TO SAVE YOU MONEY
"INTEGRAL DRAIN SCREEN" and "IMPROVED FLOW SYSTEM" provides

1. Lowest power in heavy media system
2. Uniform volume and specific gravity of media
3. No blocking of refuse compartment by near-gravity middlings

FUEL PROCESS HEAVY MEDIA COAL WASHER

FUEL PROCESS COMPANY

900 D STREET, SOUTH CHARLESTON, W. VA., BOX 8455

VICTAULIC®

METHOD OF PIPING

VICTAULIC HAS EVERYTHING...

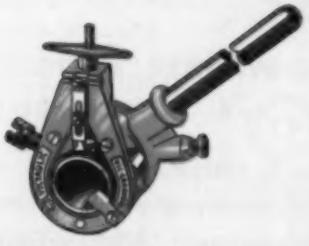
VICTAULIC COUPLINGS
Simple, fast, reliable. *Styles 77, 77-D,* for standard uses with steel or spiral pipe, — *Style 75* for light duty. Other styles for cast iron, plastic and other pipes. Sizes ¾" to 60".

ROUST-A-BOUT COUPLINGS
For plain or beveled end pipe *Style 99.* Simple, quick, and strong. Best engineered and most useful plain end coupling made — takes a real "bull-dog" grip on the pipe. Sizes 2" to 12".

VICTAULIC SNAP-JOINTS
The new, boltless, speed coupling, *Style 78.* Hinged into one assembly for fast piping hook-up or disassembly. Hand locks for savings in time and money. Ideal for portable lines. Sizes 1" to 8".

COUPLINGS FOR EVERY PIPING JOB

VICTAULIC FULL-FLOW FITTINGS
Elbows, Tees, Reducers, Laterals, *a complete line*—fit all Victaulic Couplings. Easily installed — top efficiency. Sizes ¾" to 12".



VIC-GROOVER TOOLS
Time saving, on-the-job grooving tools. Light weight, easy to handle — operate manually or from any power drive. Sizes ¾" to 8".

PLUS FITTINGS AND GROOVING TOOLS

"EASIEST WAY TO MAKE ENDS MEET"

Promptly available from distributor stocks coast to coast.
Write for NEW Victaulic Catalog-Manual No. 57-H

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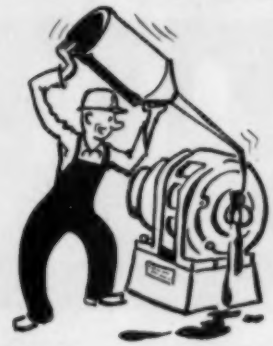


Here's Help on Your Maintenance Problems

The maintenance section in this Guidebook (pages 160-173) provides a practical working manual on maintenance principles, operation and experience at hundreds of efficient mines.

But unless all your problems are already solved, be sure to watch the regular monthly issues of *Coal Age* for the new ideas, improved methods and better equipment that are popping up all the time.

That kind of useful information may turn up in *Coal Age's* mine descriptive articles, in special maintenance studies, in the "Operating Ideas" or "Equipment News" sections.

Maintenance is one of the 21 major mining functions *Coal Age* covers regularly and consistently, to help you make your job better.

COAL AGE

Mine Management's Leading Idea Source Since 1911

How Many of These Meetings Do You Attend?

W. Va. Mining Institute
Kentucky Mining Institute
Illinois Institute
Central Appalachian Sect.
CMIA
MIIA
Open-Pit Association
National Safety Congress
National Coal Assoc.
American Mining Congress

Coal Age's Reports Put You Right In the Front Row

These are but a part of the 20-odd major industry meetings *Coal Age* editors attend each year as part of their job in keeping you informed of what the industry's leaders are doing and thinking.

Their specially written digests highlight the significant trends and useful developments you'd pick up if you were able to be there in person.

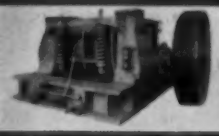
An exclusive service offered by no other coal magazine, *Coal Age's* Meeting Reports are one of the many *Coal Age* features that make your reading time more resultful.

COAL AGE
Mine Management's Leading Idea Source Since 1911

McLANAHAN SINCE 1835

CRUSHERS *for COAL and REFUSE*

SINGLE ROLL



Rockmaster — High in capacity and ruggedly constructed, it crushes hardest rock, slate and similar mine refuse.

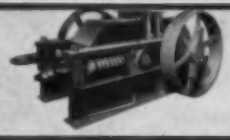
Super Black Diamond — An all-steel, intermediate-duty crusher, this provides many Rockmaster features at moderate cost.

Black Diamond — Steelstrut Toggle protection against uncrushable materials and quick size adjustment are features of this fabricated steel crusher.

Bantam Buster — This is a portable, low-cost unit with a high ratio of reduction. Trouble-free maintenance is a feature.

DOUBLE ROLL

Black Diamond Double Roll — This was designed for moderate to fine reduction of coal where a low ratio of reduction is satisfactory.



Heavy-Duty Double Roll — Economical and noted for service, it is ideal for fine reduction of mine refuse.

TRIPLE ROLL

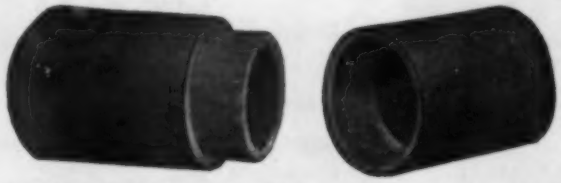
Black Diamond Triple Roll — Radically new 2-stage design reduces run-of-mine and direct open pit feed coal to fine sizes.

Bulletins Available on All Crushers

McLanahan and Stone Corporation
250 Wall Street, . . . HOLLIDAYSBURG, PA.
Mine, Pit and Quarry Headquarters Since 1835

SUTPHEN'S WOOD PIPE FOR MINE SERVICE

Sutphen machine-made wood pipe is recommended for all types of mine service. It is particularly endorsed for drainage lines.



PETER O. SUTPHEN WOOD PIPE sowing Tenon and Socket Joints which drive tight and swell tighter after saturation.

WOODS USED: California red wood, clear, all heart stock—rot resistant and termite resistant. White pine. Hard pine. Special hard wood—for flushing culm and other abrasive materials. Wood pipe is not affected by electrolysis.

SIZES: Made in sizes from 3 in. up to and including 24 in. for pressures up to 172 lb. per sq. in. Pipe lengths up to 12 ft. Shorter lengths can be furnished to lay around curves without fittings. (Sutphen wood pipe carries 14% more water than metal pipe due to less friction.)

JOINT FITTINGS: Fittings can be supplied for connections to either wood or metal pipe.

COST OF LAYING: Much less than for cast-iron pipe. No special labor or material needed in making joints. Its lightness permits easy laying.

PETER O. SUTPHEN

(Est. 1943)

SUCCESSOR TO A. WYCOFF & SON COMPANY (EST. 1855)

Underground and Exposed Wood Water Pipe

Box 58 Everett, Pa. Phone 39

Continuous Miners . . . Or Conventional Loading Machines?

There's plenty going on in application of both types. It's not an easy job to keep ahead of the many new developments.

One sure way—endorsed by thousands of top mine officials—is to check your monthly *Coal Age* issues carefully.

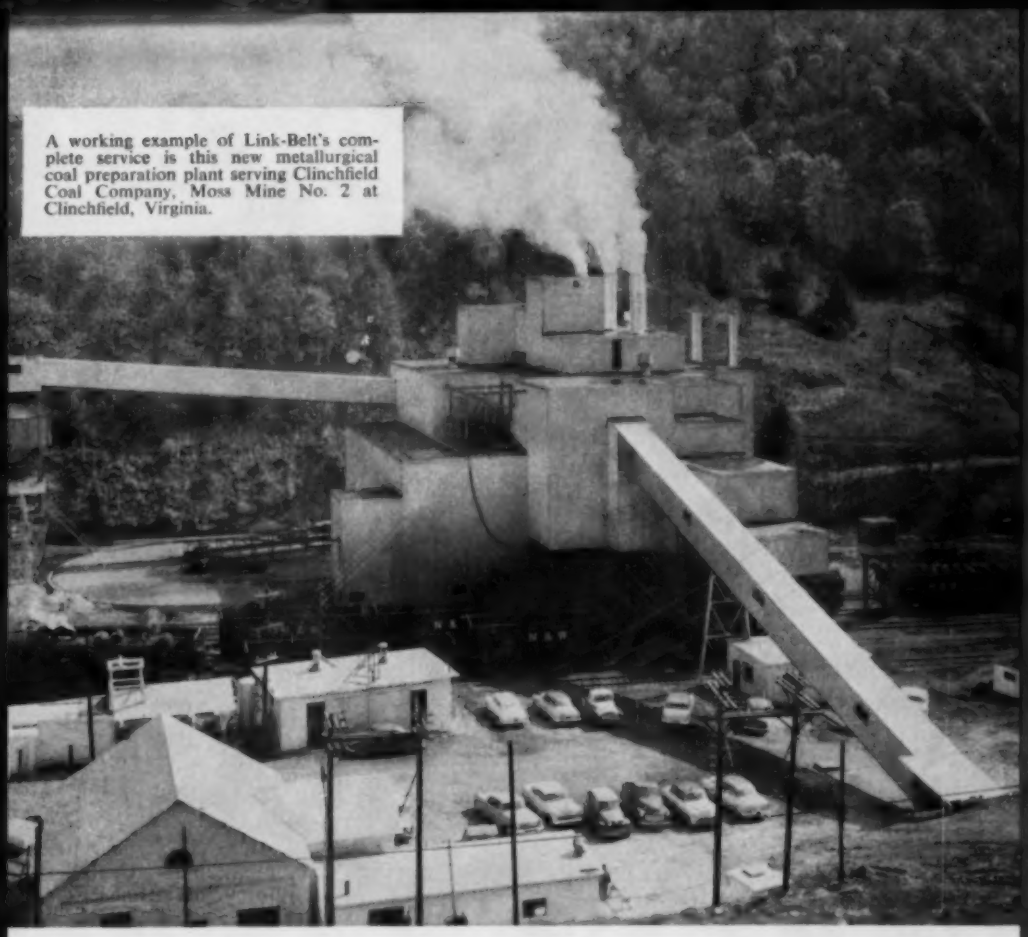
Changing mining methods, new machinery, better auxiliary equipment and maintenance, operating experience at the most efficient mines, come to you first-hand in reports by *Coal Age* editors and articles contributed by leading mine officials.

The Deep-Mining Guidebook in this issue covers all phases of current mine planning and operation. *Coal Age's* monthly issues will alert you to the constant changes going on in the industry.

Underground coal loading is one of the 21 major mining functions *Coal Age* covers regularly and consistently, to help you make your job better.

COAL AGE

Mine Management's Leading Idea Source Since 1911



A working example of Link-Belt's complete service is this new metallurgical coal preparation plant serving Clinchfield Coal Company, Moss Mine No. 2 at Clinchfield, Virginia.

LINK-BELT offers one source...

components or complete plants

for modern coal preparation

THE up-to-date plant pictured above is one example of Link-Belt's ability to completely design, equip, and erect coal preparation facilities. With over 60 years' experience and a complete line of components, we are in a unique position to fulfill all your needs. And, as a "single-source" Link-Belt will accept full responsibility for the satisfactory performance of the plant.

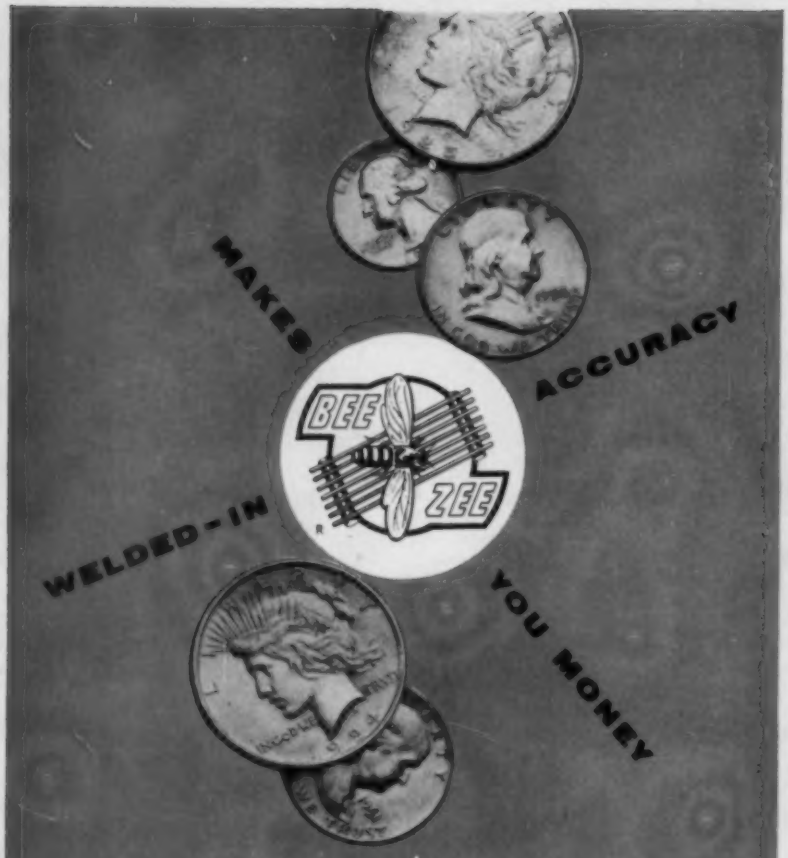
If there is need for modernizing your present installation, Link-Belt can supply you with components engineered to bring new efficiency to your operation.

Take advantage of this experience by calling your nearest Link-Belt office for an obligation-free analysis of your specific needs. Ask for Link-Belt's new coal preparation Book 2655.

LINK-BELT

COAL PREPARATION AND HANDLING EQUIPMENT

LINK-BELT COMPANY: Chicago 9, Birmingham 3, Cleveland 20, Denver 2, Detroit 4, Huntington 9, W. Va., Indianapolis 6, Kansas City 8, Mo., Louisville 2, Pittsburgh 13, Seattle 4, St. Louis 1, Scarboro (Toronto 13), Springs (South Africa). 14.010

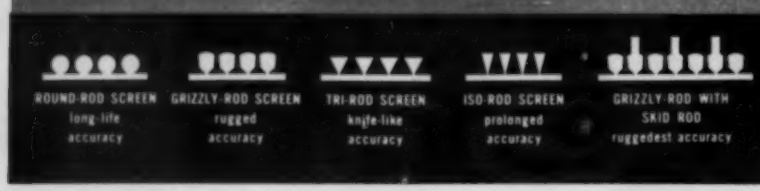


Endless shaking, vibrating or pounding doesn't alter the slot openings of Bee-Zee Screens. Screen rods are welded at every point of contact to tie rods...fused perfectly and precisely by electronically-controlled welding equipment.

Shape and thickness of rod...shape and size of screen...width and length of slot–these are always custom-selected when you order Bee-Zee Screens. Special alloy stainless steel resists abrasion ...can't rust or corrode. Built-in tension fights fatigue.

Write, wire or phone Galesburg 4397 collect for catalog and specific information on screens for your sizing, deliquefying, filtering or other screening operation.

BIXBY-ZIMMER
ENGINEERING COMPANY
187 Abingdon Street, Galesburg, Illinois



Can You Improve Your Skill In Supervising Men?

Handling men successfully is probably the most important job a mine official has. And it's one of management's key problems.

So it's easy to understand why our subscribers consistently rank *Coal Age*'s "Foremen's Forum" department as one of the best read sections in the magazine.

Foremen's Forum starts from the basis that you can develop and continually polish your skills in supervising workers, training new men and boosting production by better employee relations.

It recognizes that there's much more to management today than just methods and equipment. It reports the experience of seasoned mining men, analyzes essential management qualities.

If you're open to new ideas, make it a point to see Foremen's Forum every month. This month or next, you may find an answer to one of your troublesome problems.

Foremen's Forum is just one of *Coal Age*'s regular monthly departments carefully edited to help you make your job better.

COAL AGE

Mine Management's Leading Idea Source Since 1911

HIGH . . . WIDE and Handsome

profits through better recovery!

COMPTON COAL Augers

Coal Recovery Increased 35% to 65%

Compton Single Head Coal Auger available in 4 models. Head sizes 28" to 52".

Compton "Twin-Head" Auger for thin seam production. Head sizes 24" to 32".

Like countless other operators—you can watch your operational profit grow through more efficient recovery . . . better recovery with the *better* coal auger—COMPTON!

Together with other highly desirable features, the Compton patented non-clogging lump recovery head cuts coal at a high speed . . . maximum recovery in record time . . . as much as 870 tons in a 7¼ hour shift with a four-man crew.

In addition to four sizes of single head augers for normal seam recovery, the Compton "Twin-Head" auger for profitable thin-seam production is now available.

Call Compton for facts on how Compton Augers can be correctly applied to your operation. Learn how planned auger mining of "lost" coal seams can swell your operational profit to a high, wide and handsome figure!

Compton, Inc.

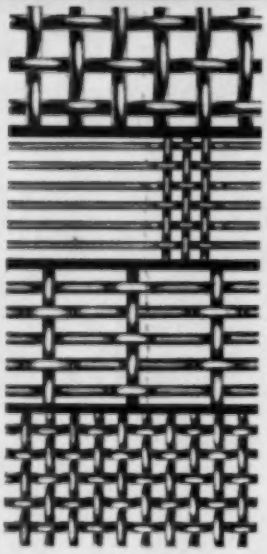
ORIGINATORS OF COMPTON LUMP RECOVERY HEADS

BOX 1946 • PHONE: MAIN 4-6383 • CLARKSBURG, WEST VIRGINIA

THE MAJOR DIFFERENCE BETWEEN WOVEN WIRE SCREENS IS THE SERVICE THEY GIVE.

Ludlow-Saylor
Super-Loy

WOVEN WIRE SCREENS



L-S Screens are tougher, stronger, more rigid—are put together with greater precision. They wear longer. Screen openings stay accurate. Edges are more carefully finished. They won't break down from fatigue or continual vibration. All this *pays off* in less downtime and replacement expense, better product uniformity, higher output.

An on-the-job test will prove L-S Screens are worth more but actually cost less because of the service they give.

Immediate Shipment of most weaves and sizes

Write For Condensed Screen Reference Catalog

SINCE 1856

L-S special-purpose industrial wire cloth and screens are woven on Ludlow-Saylor looms of stainless, monel, bronze, copper, brass, oil-tempered, high-carbon, or any other wire.

LUDLOW-SAYLOR WIRE CLOTH CO.
609 South Newstead Ave. • St. Louis 10, Mo.

SALES OFFICES: Birmingham, 1727 Sixth Ave., North; Chicago, 5807 W. Diversey; Pittsburgh, Union Trust Building; Houston, 1213 Capitol Ave.; Denver, 1530 Carr St.; WEST COAST: Star Wire Screen and Iron Works, Inc., 2515 San Fernando Road, Los Angeles; Subsidiary, Ludlow-Saylor Wire Cloth Co.

Who Makes What . . . Where Are They?

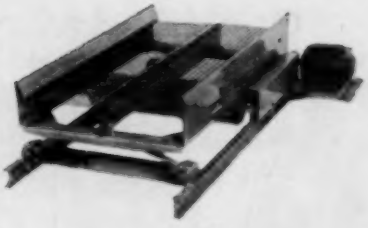
The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1957 edition.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. You'll find more helpful product information in their advertisements. Their district sales offices and distributors near you are listed in the Distributors' Index at the end of this issue

COAL AGE's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all COAL AGE subscribers

Whatever's New

DRILL BITS . . .



OR SCREENS

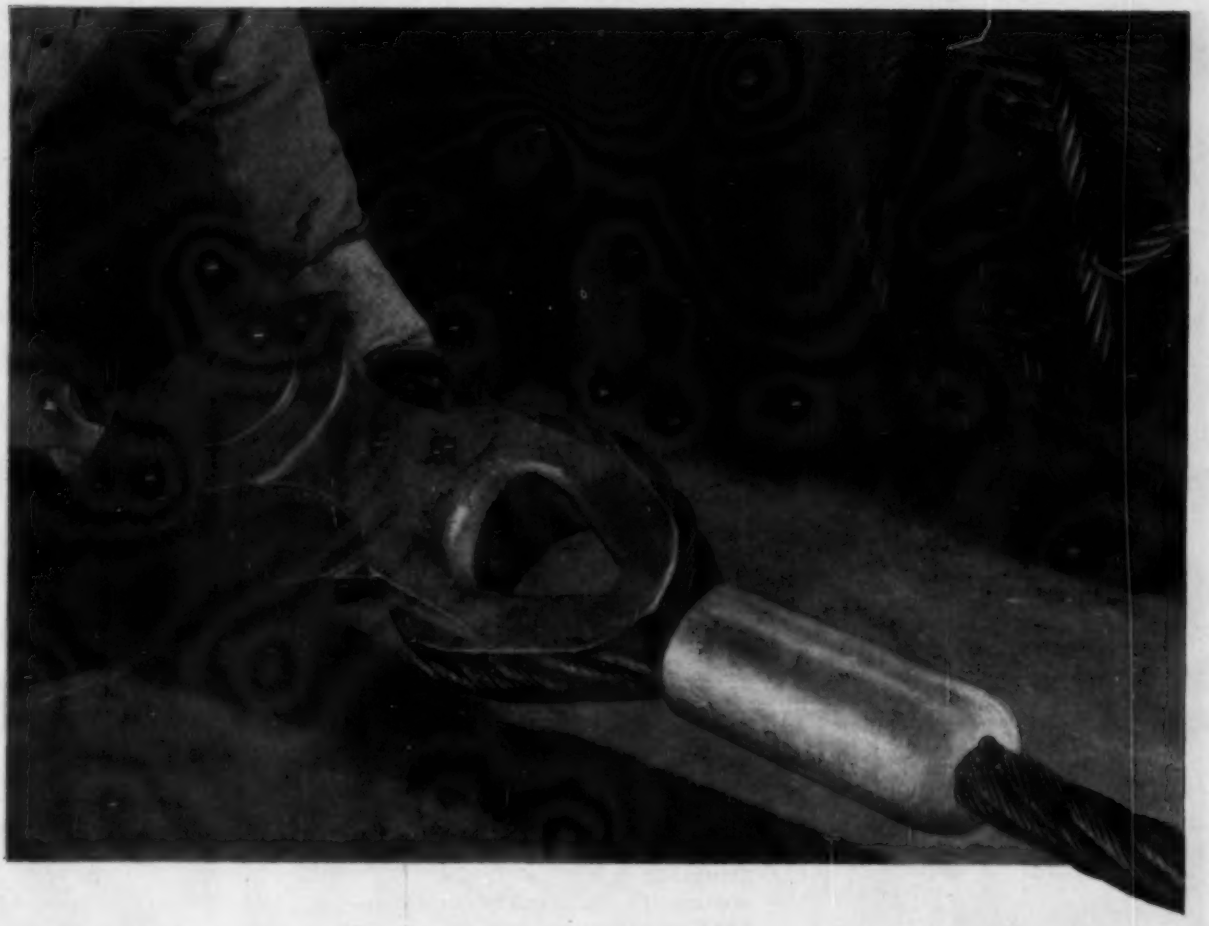
You'll See It First in Coal Age's Equipment News

You can depend on *Coal Age's* Equipment News section to keep you posted on what's new and interesting in mining machinery and equipment.

Each month, our editors cull several hundred manufacturers' announcements and news reports and prepare brief, fast-reading new product descriptions of the latest machinery, equipment and supplies. New catalogs and technical bulletins also are digested for your information.

This section is but one of *Coal Age's* regular monthly departments carefully edited to alert you on industry developments.

COAL AGE
Mine Management's Leading Idea Source Since 1911



NOW...boom pendant assemblies with full catalog strength of the wire rope

Rugged J&L boom pendant assemblies with exclusive JalKlamp splices provide extreme strength, longer service life.

JalKlamp terminals are formed by hydraulically pressing the alloy sleeve around the rope. The metal in the sleeve flows into every space between the wires and the strands of the rope. The splice is up to 20% stronger than conventional splices.

The solid steel fittings in J&L boom pendant assemblies are held tight in the loop. They cannot slip.

Investigate why J & L boom pendant assemblies last longer under toughest operating conditions. Send coupon today for complete information.

Jones & Laughlin Steel Corporation
Wire Rope Division
Muncy, Pennsylvania

☐ Please send information on J&L boom pendant assemblies.

☐ Have representative call.

Name_____

Title_____

Company_____

City_____ Zone____

State_____

J&L STEEL

Jones & Laughlin

... a great name in steel

STANDARD

FIRE-RESISTANT FUSED TROLLEY TAP

Stops Cable and Hook Pull Outs

No Top Insert Pull Outs!
Fibre glass case has molded threads, holds insert securely.

Fibre Glass Impregnated Case
Fire-resistant, sturdy, lightweight.

Takes All Regular Trolley Tap Fuses

Positive Electrical Connection
No special tools, just use a screw driver. Set screw at bottom fuse holder exceeds maximum cable size—insures positive electrical connection.

Whole Unit is Compact, Lightweight

No Cable Pull Outs!
Clamps act as strain relief, take pressure off bottom of fuse holder. Loose connections or cable pull outs are eliminated—tap is cooler operating.

Takes All Popular Cable Sizes

For full details and prices, write Dept. ...a

STANDARD DEVICES COMPANY
3231 Warrensville Center Rd. • Cleveland 22, Ohio

This BUYERS' GUIDE Is Right-Up-to-the-Minute

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1957 edition.

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COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all COAL AGE SUBSCRIBERS.

Want New Ideas . . .

Watch Coal Age's "Operating Ideas"

Mine-tested, practical ideas, new maintenance tricks, home-made gadgets that work, make up *Coal Age's* monthly "Operating Ideas" section.

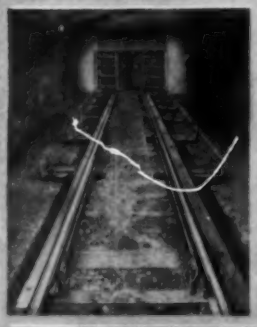
Our editors uncover many of these good ideas as they visit the mines. Others are sent to us by mine officials responsible. No matter what the object, there's only one yardstick: It must be an idea that makes a mining job safer, easier or less costly.

Check this section regularly. This month or next month, you may find just the right answer to one of your bothersome problems. Operating Ideas is just one of *Coal Age's* regular monthly departments carefully edited to help you make your job better.

COAL AGE
Mine Management's Leading Idea Source Since 1911

Half Century Rugged, Dependable profit-paying Equipment

A·M·D·CO



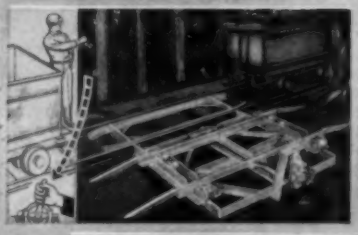
Canton Mine Door

The Automatic Door operates mechanically by weight of car on activating levers. Air power operation may be had where desirable. Operates at any trip speed. Two doors provide air lock.

Install "Canton" American Mine Door Products in your Mine. Pay us out of increased profits.

Track Switch Throwers

Electric or air operated. Route selections made by motorman at full trip speeds. Eliminates accident potential and extra man. Also ideal as Derailer.



Canton Car Transfers

No alterations to track. Quickly installed and relocated—less rib to shoot than for jump switch—no hazards of cherry picker. Anti-friction bearings for easy hand operation. Manual or compressed air models available. (Air model illustrated.)

Wet or Dry Dusting

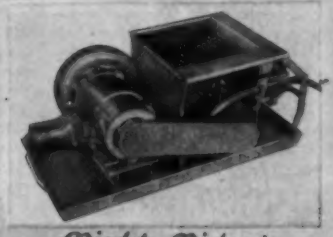
"Canton" Little Chief goes anywhere . . . rubber tire model 22½" high; skid model 18½" high for shuttle buggies, belts or mine cars; track-mounted for haulage roads. Delivers 34 to 60 lbs. dust per minute through 50 to 400 ft. 1¼" hose.

Dustmaster

The Track Mounted Hi-Pressure "Dustmaster" is the most powerful Duster ever built. Distributes dust to back areas 500 ft. from haulway.

Canton Track Cleaners

Hydraulic controls throughout clean entire track area mechanically in one pass—no costly hand labor; no dozers or loaders required. Now operating economically in coal, iron, copper, lead, potash, and salt mines.

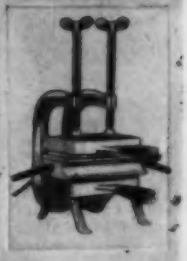


Mighty Midget

Weighs only 280 lbs. Easily moved on shuttle car. Hand cart available. Ideal for small mines . . . inexpensive . . . capacity 7 tons per shift

Canton Cable Splicer

"Canton" Cable Splicers reduce down time in splicing cable. Machine men should carry a pocketful. Just pound around cable and go on working. No special tools.



Canton Vulcanizer

Restores insulation to original condition. Used with Canton Splicers, strong as original cable.

The American Mine Door Company

2057 Dueber Ave., Canton 6, Ohio

Write for complete brochures. Please use street and zone numbers.

Want higher productivity—

Get both with LONG

New Long Model 88-C Pigloader*

For Piggyback* Conveyor Mining

Overall Operating Height—25¾ inches
Weight—14,000 pounds.

These new Pigloaders feature low operating height, simplified design and operation, minimum maintenance, and full independent crawler control. The single 40 HP electric motor drives all machine operations, with power transmitted to various functions through a simple combination of gear and chain drives. All functions are controlled hydraulically from a single bank of fingertip control valves. Maximum digging power results from application of extremely heavy duty gathering transmissions, plus the ability to employ the full 40 HP for this as well as other operations. Rated capacity—4 to 6 tons per minute; tramming speed—95 feet per minute; conveyor chain—heavy duty, 58,000 pounds ultimate strength.

New Long Model 188-C Pigloader

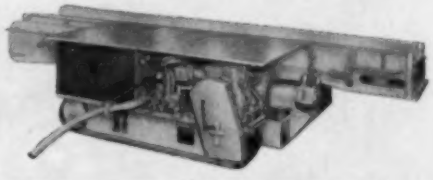
For Shuttle Car Loading

Overall Operating Height—26½ inches
Weight—15,000 pounds.

*Trade Marks Reg. U. S. Pat. Off.

Long Piggyback Bridge Conveyors

The LONG Piggyback is the original "bridge" conveyor, with basic features patented. Because it eliminates lost time for shuttle car changes, Piggyback mining assures continuous haulage and a high percentage of loading time—whether utilized with conventional loaders or with continuous mining machines. The PT-15-B (illustrated) is especially suitable for use with the 88-C Pigloader. For low seams, the new LONG PT-18 Piggyback has a receiving height of only 11".

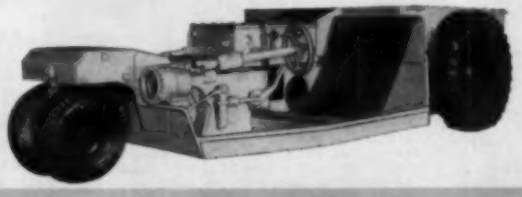


Long Mobile Room and Gathering Conveyors

The LONG Mobile Conveyor reduces moving time by as much as 60 per cent. Because the conveyor drive is crawler mounted and self-tramming, one man can relocate it in minutes. Tramming speed—45 fpm, capacity—5 tons per minute, and operating length—more than 400 feet. Available in Model M-400 (open-type pan track return) and M-500 (solid-type recirculating pan track return) with pan widths of 12 and 15 inches and pan depths of 5, 7 and 9 inches. The M-500 series eliminates fine coal accumulation under the pan line, and cleaning up after this conveyor is unnecessary.

New Long Mobile Hydraulic Coal Drill

Coal drilling becomes a one-man operation with the new LONG Mobile Hydraulic Coal Drill. Two lightweight aluminum drills are available—the 1-M-20 (one-man, 20 pounds) for drilling average holes and the 1-M-30 (one-man, 30 pounds) for larger holes or drilling in hard coal. 12-20 seconds is required to drill the average hole WITH ONE MAN. The self-tramming hydraulic power unit designed for these drills also can be used with a trailer for supply haulage or conveyor pan movement.



New Long Battery Tractor-Truck

Equipped with U.S.B.M. permissible approval plate, the new LONG Model D-2375 travels at a speed of 4 miles per hour and can quickly move trailers carrying sufficient supplies for an entire working shift, plus the men, to the section. Available in machine heights of 26" or 30", it incorporates explosion-proof U.S.B.M. approved type electrical equipment with full magnetic control, and two-speed operation in each direction.

lower operating costs?

EQUIPMENT

FOR

Continuous loading...
Mobile conveyor mining

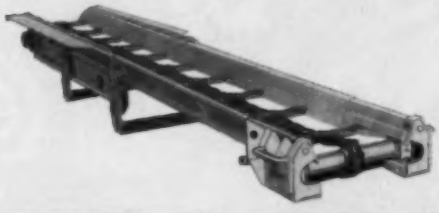
Side-Lift Type—Model 2374

Straddle Type—Model D-2111

New Long Conveyor Pan Transporters

Designed specifically for application of the LONG Piggyback Conveyor System to continuous mining, these pan transporters permit quick, easy additions to the room chain conveyor to keep pace with rapid advances by continuous mining machines. The straddle type, powered by two U.S.B.M. permissible 5 HP motors, can transport *at one time* six or seven conveyor pans (each 6′ long), plus tail piece.

Powered by one permissible 10 HP motor, the side-lift type has two side-lifting booms for transporting three conveyor pans, plus tail piece, to extend the room conveyor. Also included with this model is a hydraulic driven winch with 150 feet of wire rope.



Long 400-DBH Skid-Mounted Conveyor

High capacity transportation is provided by the LONG 400-DBH, 15-inch room and gathering conveyor, designed for LONG Piggyback Conveyor Mining. Furnished with 5″, 7″ or 9″ deep pans—the 400-DBH offers capacity to 300 tons per hour in maximum lengths of 500′. Standard chain speed is 196 fpm.

Long Type 640 Elevating Conveyor

Provides high-capacity transportation as either a shuttle car elevator or an elevating conveyor in the LONG Piggyback Mining System. It offers the strongest chain and flight combination in an underground elevating conveyor, and its 10½″ height makes it desirable for receiving shuttle car loads. Open or permissible type electrical equipment.

The LONG Company
OAK HILL W. VA.

MAIL COUPON FOR COMPLETE INFORMATION!

Gentlemen:

☐ Please send details on the complete line of LONG Equipment

Name _____ Title _____

Company _____

Address _____

City _____ Zone ____ State _____

What we learned about from salesmen's

● **This 5' x 16' vibrating shaker** has four segments—all made from Stainless Steel. Top impact segment processes about 40,000 tons before replacement. Bottom three segments process about *120,000* tons before replacement. In addition, there is very little blinding.

coal preparation costs call reports

WE DON'T ARGUE the fact that Stainless Steel chutes, screens and other equipment have what appears to be high initial cost. Why, then, do so many coal preparation plants use Stainless Steel for chutes, screens, and other equipment if the initial cost of Stainless equipment is higher than other materials? The answer seems to be that *they can't afford the cheap materials!*

A check of salesmen's call reports reveals this: the companies that keep the most accurate cost records are the ones that use the highest percentage of Stainless Steel equipment. This bears out our contention that Stainless Steel equipment is much cheaper in the long run. In fact, wherever there is a situation involving severe abrasion and corrosion (as in corrosive wash water), *nothing* can equal Stainless Steel in its ability to process *more tons of coal per dollar of equipment cost.*

Naturally, you get the most for your money when you install Stainless Steel equipment right at the beginning, in new equipment. But it's never too late to start saving; and you can buy Stainless Steel strip and sheets right from your local steel warehouse for use in chutes and the like. Make it *USS* Stainless Steel to be sure of service-tested quality.

Stainless Steel outlasts carbon steel chutes seven to one . . . and then some! In actual side-by-side tests, this Stainless Steel chute outlasted seven carbon steel chutes, and the Stainless chute was still in good condition. This plant estimated that a $900 investment in Stainless Steel saved $30,000 in replacements! And because of Stainless Steel's slideability, no build-up disrupted operations.

This Stainless Steel dewatering sludge screen vibrates at 1,200 rpm, will process more than 200,000 tons of coal in its average 14-month service life. Operators of this plant are also impressed by the way Stainless works for them when the plant is *shut down.* It doesn't rust or blind, is always ready to go into service again.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS • UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS STAINLESS STEEL

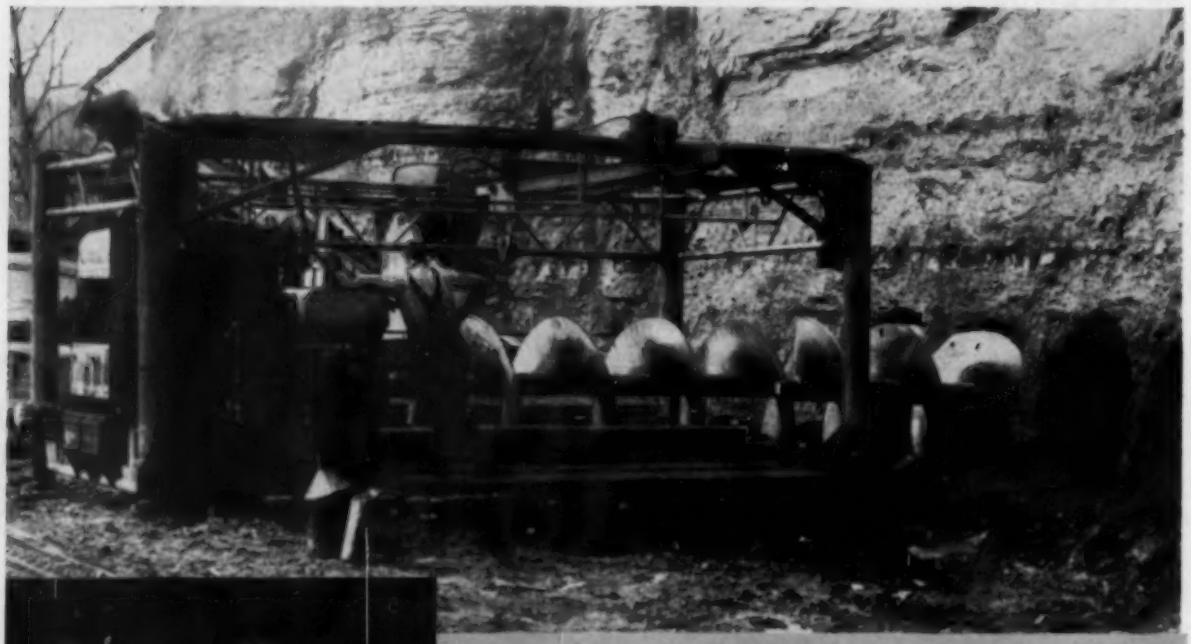
SHEETS • STRIP • PLATES • BARS • BILLETS • PIPE • TUBES • WIRE • SPECIAL SECTIONS

7-1658

UNITED STATES STEEL

FOR MORE PROFITABLE

CARDOX presents 5 practical answers to rising costs



CARDOX® AUGER MINER

MODEL 235

for lowest cost continuous SURFACE COAL MINING — UP TO 700 TONS A DAY

The most economical method for mining coal, on a per ton basis! Operating easily in any 26-foot pit, the Cardox AugerMiner, Model 235, drills under the overburden to bring out pure coal—from holes up to 50″ in diameter. With only a 3-man team, it can work almost continuously because it is *self-positioning* and *self-moving*. As the AugerMiner spans *two* holes, *augers are stored in the completed hole and recovered as needed for extension into the new hole to any practical length desired.* Providing the BIG power you need, the CARDOX AugerMiner is an extremely rugged machine that needs minimum maintenance. Its simple design also makes maintenance easier.

CALL FOR A CARDOX ENGINEER

Ask to have a Cardox Engineer give you the full story on Cardox AugerMiner Model 235 and other models. Let their records show you why Cardox AugerMiners offer you the lowest cost means yet developed to mine coal.

CARDOX

PRODUCTION!

new improved

semi-portable

AIRDOX

compressor

The familiar AIRDOX Compressor is now available with either rubber-tired wheels or flange wheels for track use. Mounted on a heavy-duty frame with towing bar, this semi-portable unit can be readily moved from place to place within the mine.

AIRDOX Non-Explosive Mining Method—

The time-tested system that cuts costs five ways:

- Produces less fines in face preparation
- Rolls coal forward for faster, easier loading
- Easier on "tender" roofs — cuts timbering and bolting
- Lowers cleaning costs by minimizing fines
- Reduces degradation—no shattered coal.

new

CARDOX

horizontal hydraulic

HEAVY DUTY DRILL

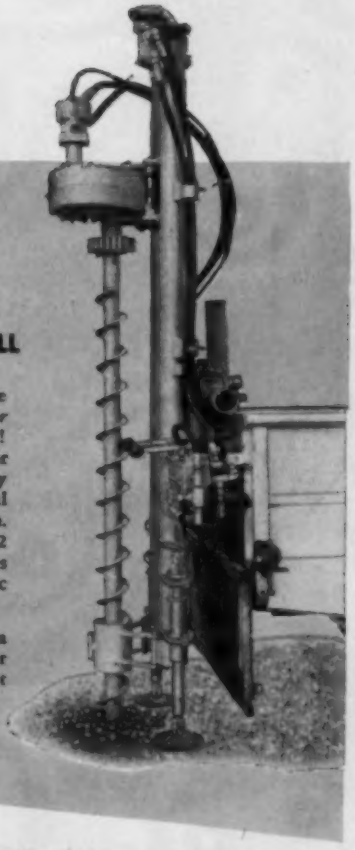
A brand new, more powerful drill to speed up high wall or bank drilling of blast holes. Just roll it up to the job and drill. New water-cooled engine is amply powered to handle drills up to 8" in diameter. The new hydraulic coupling provides virtually shock-free transmission of power to the drill, saves wear and tear. Wide, rigidly reinforced frame insures stability in operation. Unit is also available in a self-propelled model.

new model

CARDOX

hydraulically powered

GENERAL PURPOSE DRILL



You'll probably agree, it's the most downright *usable* drill, *for more jobs*, than you've ever seen! Mounts on any truck, crawler or farm tractor . . . and drills at any angle from horizontal to vertical and in any lateral direction. Handles augers from 3 to 12 inches in diameter, at feed rates up to 20 fpm. All-hydraulic power and controls.

Dismounted, it doubles as a trench drill or can be used for horizontal drilling at different levels.

Get Full Data on Other CARDOX Equipment to Help You Cut Costs

Besides the equipment shown here, CARDOX offers you a broad line of non-explosive mining equipment that includes:

- **Other smaller Surface Type CARDOX AugerMiners**
- **CARDOX Underground Drilling Equipment**
- **Other Horizontal and Vertical Drills**

Write for full information, or ask your CARDOX Engineer

CARDOX CORPORATION • 307 North Michigan, Avenue • Chicago 1, Illinois

WAREHOUSES and DISTRICT OFFICES

Harper, West Virginia
Phone: Beckley—Clifford 3-4812

Benton, Illinois—Box 537
Phone: Benton 8-3821

St. Clairsville, Ohio—Box #1
Phone: St. Clairsville 619

Pikeville, Kentucky
Route 2, Box 571
Phone: Robinson Creek 5

Louisville, Colorado
Phone: Boulder
Hillcrest 2-7298

Library, Pennsylvania
Box 427
Phone: Tennyson 5-6910

Camden-on-Gauley, W. Va.
Phone:
Camden-on-Gauley 2181

Evansville, Indiana, Box 84
307 Northwest Fifth St.
Phone: Harrison 2-8944

Ottumwa, Iowa
Phone: Ottumwa
Murray 4-6564

Packed with Power!

Manitowoc 4500 Boosts Mining Output

Smart mine operators with an eye on output figures have found that the Manitowoc 4500 loads out more tonnage faster — at greater profit. Here's a true mining machine — always ready to increase output — either as a 5½-yd., big capacity shovel, or a long reach, 6-yd. dragline.

FIRST WITH UNIT DRIVE. The Manitowoc 4500 is powered by a single diesel engine instead of independent electric motors and accessories. You get greater operating efficiency — less power loss with unit drive, pioneered and developed by Manitowoc for large crawler excavators.

UNMATCHED SIMPLICITY. You're rid of all the headaches and special maintenance problems brought on by electric drive. Several electric motors, generators, control boards and thousands of electric wires and connections are eliminated. Your regular mechanics easily handle routine maintenance and servicing.

"SMALL MACHINE" MOBILITY. Working range on the job is extended because there's no restrictive trailing cable — no need to stay close to power installations. When moving between jobs, the unit can be shipped on railway cars or highway trailers — then set up, ready to go, in less than a week.

Discover why more and more mines are switching to Manitowoc — Contact your distributor now!

Manitowoc Engineering Corp., Manitowoc, Wis.

- **Simple Design Throughout for Full Power — Less Deadweight — Less Downtime**
- **High Lift Booms Extend Reach and Height**
- **Tubular Dipper Stick Evenly Distributes Digging Strain**
- **Only 15 Gears and Sprockets — Only Working Gears Turn**
- **Amazingly Low Ground Pressure With Extra Long, Wide Crawlers**
- **Torque Converter Drive — Air Controls — Eliminate Operator Fatigue**

MANITOWOC

SHOVELS 1-5½ YD. Speedcrane CRANES 20-100 TON

McCARTHY AUGER DRILLS

- 60 TO 75 TONS PER HOUR
- SELF-MOVING FROM HOLE TO HOLE
- 2- OR 3-MAN CREW
- MINES HIGH-QUALITY COAL

● Twelve models of McCarthy Coal Recovery Drills auger-mine bonus coal at THE LOWEST operating cost per ton. They operate easily in narrow strip pits. Hydraulic controls simplify alignment, augering and changing position. Let us recommend the right cost-saving model for your property. Write for Bulletin M-101 and M-102.

SELF-PROPELLED

Horizontal Earth and Rock Boring Auger Drills 150 ft. Drilling Depth

● The self-propelled unit permits speedy, economical blast-hole drilling from hole to hole. It takes just a few seconds to disengage the power unit from the auger drive shaft, change position, and begin drilling again. The unit is easily attached to the McCarthy truck-mounted earth and rock boring drills now in use.

TRUCK-MOUNTED

● Truck-mounted horizontal drills are highly versatile. The drilling unit mounts lengthwise or crosswise on the truck bed for spotting hole locations faster. Drilling height from the ground ranges from 4½ to 7 ft. Four separately operated levelling jacks permit close alignment. Write for Bulletin M-105.

HEAVY-DUTY VERTICAL

Model 106-24—World's Fastest Heavy-Duty Vertical Auger Drill

● Bores vertical blast holes faster than any other auger drill. New gear reduction permits slower auger rotation for drilling larger holes deeper in harder rock formations. Augers 8" and 9" dia. drill holes to depths of 125 ft. for use of new type explosives. Controls can be placed at rear and auger racks can be furnished if desired. Write for Bulletin M-100.

FINGER-TIP CONTROL

Gives Desired Rotating Speed Of Auger

HEAVY RUGGED

HYDRAULIC FEED

Provides Any Speed Up To 8 Feet Per Minute Horizontal Feed Of Drill

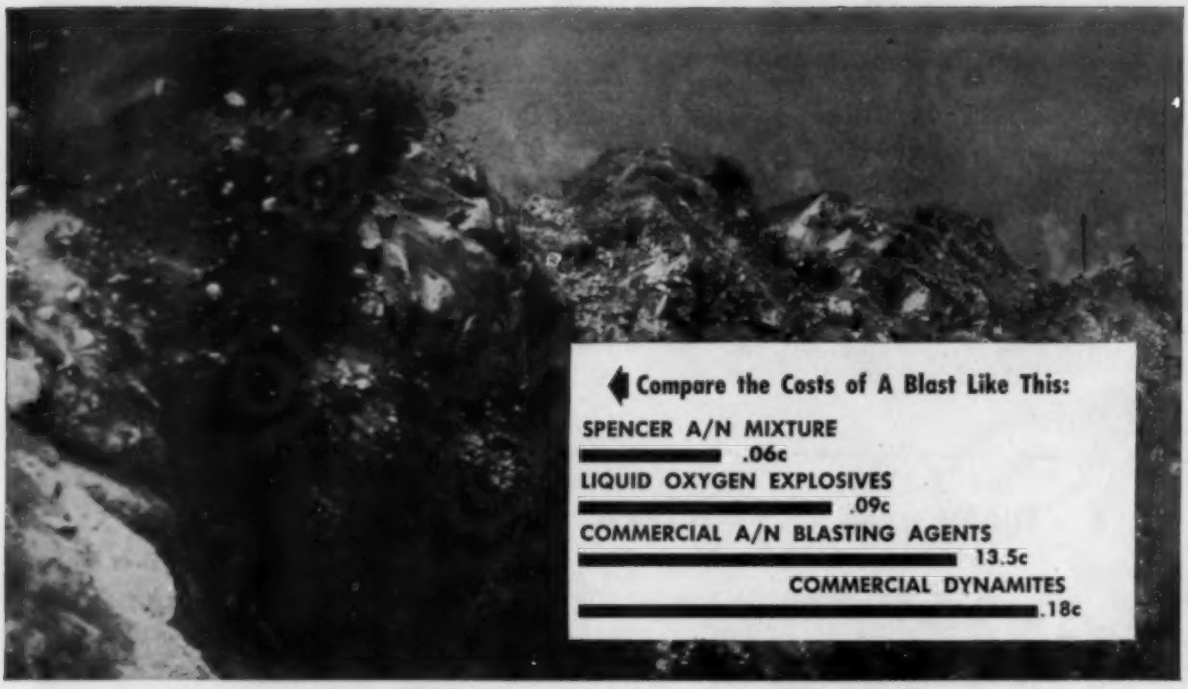
POWERFUL

MANUFACTURED BY

THE SALEM TOOL COMPANY

[illegible] SOUTH ELLSWORTH AVE. · SALEM, OHIO, U. S. A.

SALEM



SAVINGS UP TO 50% are common when Spencer Prilled Ammonium Nitrate is used for blasting.

How a Kansas Company Saved $45,000 On Explosives Cost In Just One Year:

Read how Spencer Prilled Ammonium Nitrate cuts blasting costs, and gives better fragmentation — yet stores and travels safely!

You can cut your blasting costs with Spencer Prilled Ammonium Nitrate. A Kansas user, the Pittsburg and Midway Coal Company, cut $45,000 from its explosives bill in just one year! A rock producer reports net savings of $25,000 on a job involving about a million cubic yards of rock.

Spencer prills blast better because their spherical structure offers an increased surface area. This extra area produces more explosive speed and energy—about ¼ more, according to recent scientific investigations.

You get better fragmentation, too, with Spencer Prilled Ammonium Nitrate. This means you can move as much as 25% more material.

Mixing is never a problem with free-flowing Spencer Prilled Ammonium Nitrate. Shipped in polyethylene-lined bags, Spencer prills resist caking and help assure a tightly-packed mixture. In even the simplest mixing operations, round Spencer prills get a better coating of carbonaceous material. And that means a better blast.

Safe and easy to handle, Spencer Prilled Ammonium Nitrate is not cap sensitive, either by itself, or in carbonaceous mixture. In laboratory tests, rifle bullets were fired repeatedly into these mixtures without detonation. With dynamite, the same test produced violent explosions every time.

Also, it costs less to ship Spencer Prilled Ammonium Nitrate. That's because prills are so safe they can be shipped at ordinary freight rates rather than at the rate fixed for explosives.

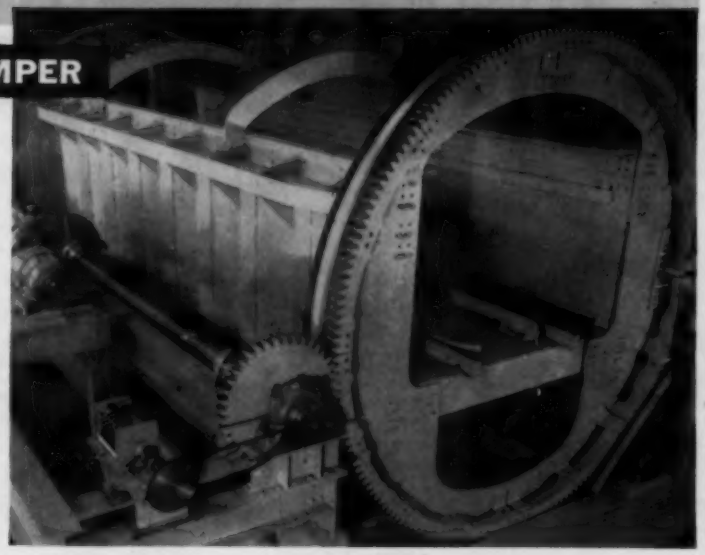
If you, too, want to cut costs and increase your blasting efficiency, let us help you develop a low-cost blasting program with Spencer Prilled Ammonium Nitrate. Write or phone Spencer Chemical Company, Dwight Building, Kansas City 5, Missouri, BAltimore 1-6600.

SPENCER CHEMICAL COMPANY

• 610 Dwight Building • Kansas City 5, Mo. • BAltimore 1-6600

THE NOLAN PROFIT-PAIR
to meet modern mining requirements

NOLAN ROTARY CAR DUMPER



The newest, safest design in high-speed dumping through full 360° arc. Fully automatic with selective manual control. The result of 50 years of Nolan experience and progress in mine car dumping and control equipment.

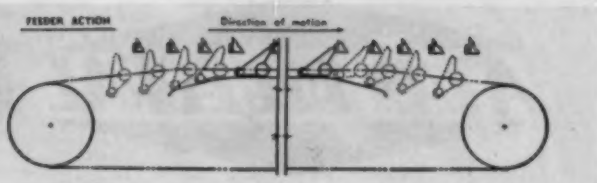
FEATURES:

—Designed for Today's High Capacity Mine Car
—Gear Driven through Flame Hardened Gears
—Complete with Base Frame, Dump Sheets, and Liner Plates
—Anti-friction Bearings Throughout
—Wide Faced Dump Rings of Special Alloy Steel
—Equipped with Nolan Patented Cushioned Rail Aligning Stop

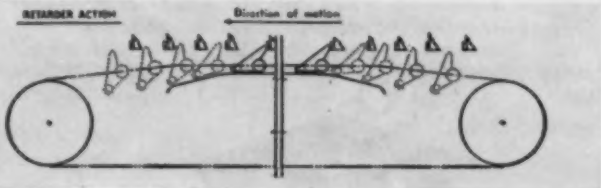
NOLAN CUSHION-ACTION TRIP FEEDER-RETARDER

The NOLAN Cushion-Action Feeder-Retarder makes possible the easy, accurate control of mine cars . . . and eliminates the wracking, jolting, inflexible action so common in ordinary chain control types.

Through the ingenious design of dogs, rails and chain, the feeding and retarding of mine cars becomes an easy, gentle, positive action. The diagrams at the right picture the Cushion-Action of this new NOLAN advancement, available only through NOLAN. Consult us for adaptation of the new NOLAN Cushion-Action principle to your particular feeder-retarder problems.



Feeder dog is pivoted on pin carrying outboard rollers of chain. Tail of dog has roller. Third track under center of chain governs position of dog with relation to vertical. Note difference in angle between chain track and dog track. As dogs progress along their track, they gradually assume an upright position and engage their respective pusher pads. At other end of frame, dogs ***gradually*** drop away from their pads. No straining, jolting or jarring as dogs engage and disengage.



Retarder dogs operate on same principle as feeder dogs and are situated adjacent to them. Gradually assume upright position and engage their respective retarder pads, holding back cars firmly and steadily. At end of chain, retarder dogs ***gradually*** drop away from their pads, without snapping or wracking of cars.

NOLAN AGENTS:

Huntington Supply & Equipment Co.
Huntington Nat'l Bank Building
Huntington, West Virginia

John Lloyd & Sons
33 Bennett Building
Wilkes-Barre, Pennsylvania

E. C. Horne Machinery Company
1726 Champa Street
Denver 2, Colorado

George C. Hutchinson, Jr.
1304 Koenan Building
Pittsburgh, Pennsylvania

Frank C. Memmott
P. O. Box 154
Castle Gate, Utah

Amos A. Culp
429 South 24th Street
Birmingham 5, Alabama

John North Associates
P.O. Box 105
Harbert, Michigan
(Chicago District)

THE NOLAN COMPANY
BOWERSTON, OHIO

NOLAN

SAFEGUARD YOUR MACHINERY against misalignment

by specifying

AJAX®

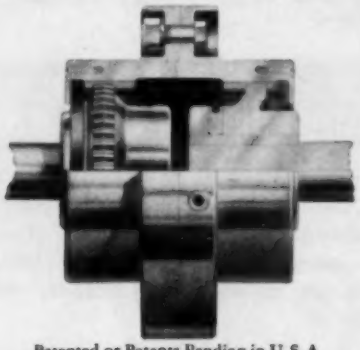
FLEXIBLE COUPLINGS

When you remember that all the horsepower goes through the coupling, you will appreciate the importance of protecting your equipment against excessive bearing wear due to misalignment between driving and driven units. Avoid the high costs of shutdowns and costly repairs by specifying AJAX Flexible Couplings. They are made in two basic types and in a wide range of capacities for original equipment and maintenance. Specify AJAX on new equipment and write for catalogs covering your replacement requirements.

AJAX DIHEDRAL

FLEXIBLE COUPLINGS

Revolutionary Dihedral design makes it possible to handle offset and angular shaft misalignment, up to a total of 12 degrees. They stand up under conditions where constant weaving and twisting is encountered. Strip mining machines, shovels, breakers, winches and hoists are typical applications where AJAX Dihedral couplings are increasing the performance and reliability of mining equipment.

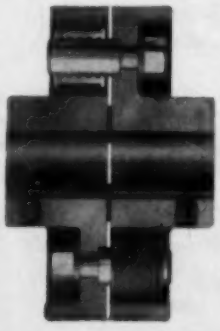


Patented or Patents Pending in U. S. A and foreign countries.

A complete range of sizes, specify AJAX Dihedral couplings on trouble jobs and new equipment.

AJAX®

RUBBER-BRONZE BUSHED COUPLINGS



Widely used on direct driven equipment such as compressors, pumps, generators, and other direct driven equipment. Ideal for use under moisture and abrasive conditions. Standard of industry for nearly 40 years. Available as original equipment by leading manufacturers. It pays to specify AJAX. Representatives from coast to coast.

AJAX FLEXIBLE COUPLING CO. INC.

Phone Westfield 295 — **Westfield, New York**

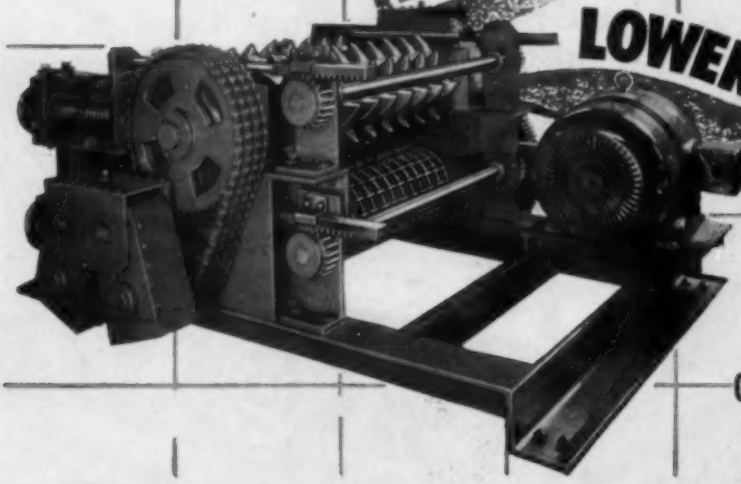
the HANNA* story about... GUNDLACH crushers

The GUNDLACH CRUSHER crushed more coal in 9 months than previous crushers crushed in a full year!

INCREASED PRODUCTION!

The GUNDLACH CRUSHER averaged 390 TPH crushing over 1,000,000 tons with total maintenance cost... only $318.00

LOWER MAINTENANCE!



Or a Maintenance Cost of 32¢ per 1000 Tons!

*

In January 1956, Hanna's Georgetown, Ohio Preparation Plant, one of the largest coal cleaning plants in the United States, installed their first **GUNDLACH** Crusher which was required to reduce 7" x 1¼" washed coal to 1¼" top size at a rate of 350 TPH.

Prior to the installation of the **GUNDLACH** Crusher, Hanna encountered trouble with an oversize product (plus 1¼") overloading the recirculation screens and conveyors, which in effect decreased overall plant capacity.

Not only did the **GUNDLACH** Crusher more than meet the capacity required, but it also eliminated the overloading condition in the recirculating equipment which greatly increased overall plant capacity. In addition the **GUNDLACH** Crusher as compared to the crusher it replaced reduced the percentage of fines, consequently better screening resulted. It delivered an average of 390 TPH, crushing over a million tons from Jan. 13 to Oct. 31, 1956 and . . . at the relatively negligible low cost of only $318.00 for total maintenance, broken down as follows:

Replacement Parts: (Includes welding rod for tooth build-ups)	$ 36.00
Labor: Hanna's actual cost for tooth build-ups and installation. (Some at overtime rate)	$282.00
Total cost per 1,000,000 tons	$318.00

BECAUSE OF THE OUTSTANDING PERFORMANCE OF THIS CRUSHER, HANNA HAS RECENTLY PURCHASED FOUR MORE GUNDLACH TWO-STAGE CRUSHERS.

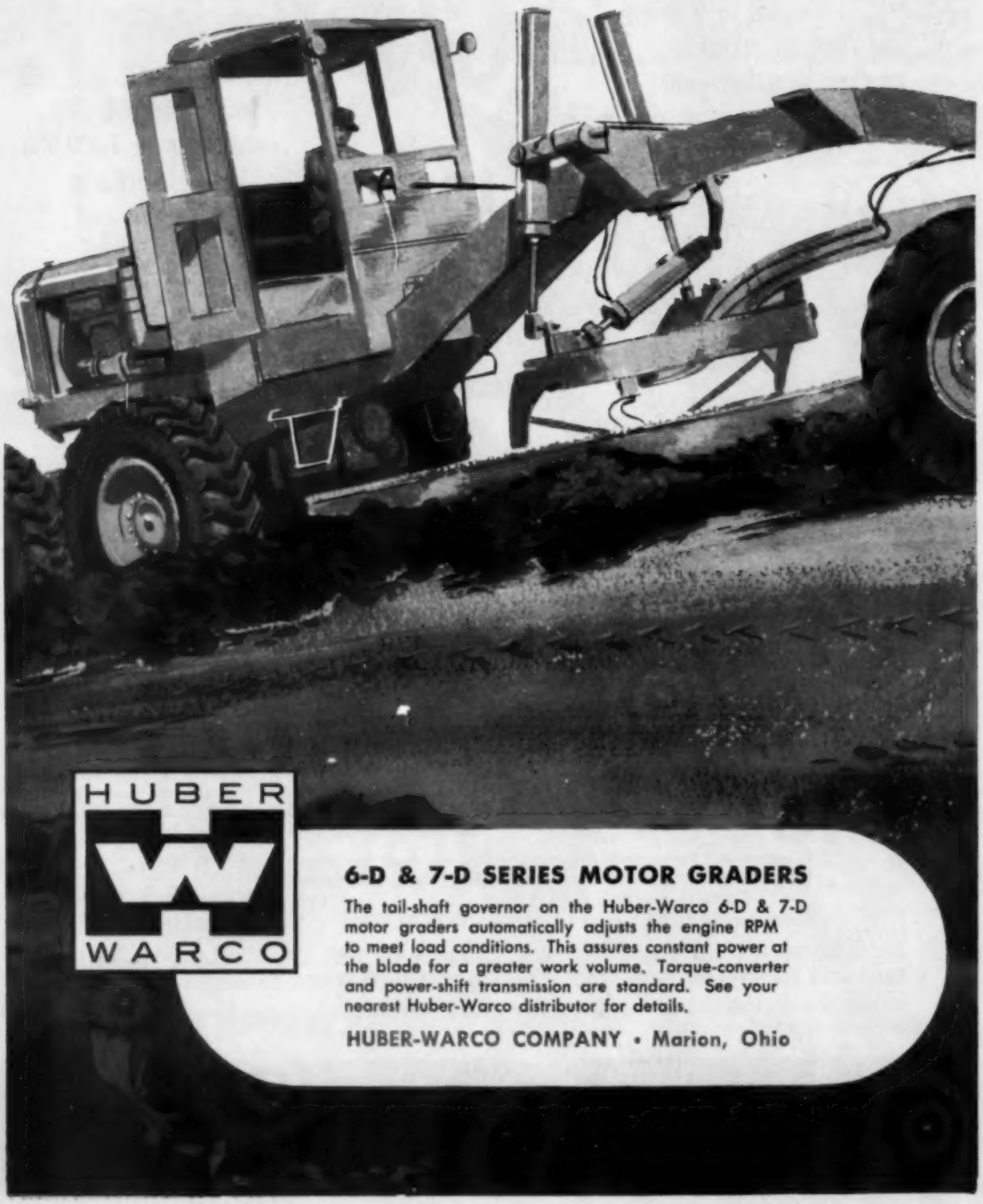
Perhaps we can help you as we have helped Hanna. We have a crushing engineer in your area, just give us a call.

T. J. GUNDLACH MACHINE CO.

DIVISION OF J. M. J. INDUSTRIES, INC.

BELLEVILLE, ILLINOIS

CONSTANT
BLADE POWER



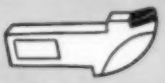
HUBER
W
WARCO

6-D & 7-D SERIES MOTOR GRADERS

The tail-shaft governor on the Huber-Warco 6-D & 7-D motor graders automatically adjusts the engine RPM to meet load conditions. This assures constant power at the blade for a greater work volume. Torque-converter and power-shift transmission are standard. See your nearest Huber-Warco distributor for details.

HUBER-WARCO COMPANY • Marion, Ohio

THERE IS A KENNAMETAL* BIT FOR EVERY MINING OPERATION

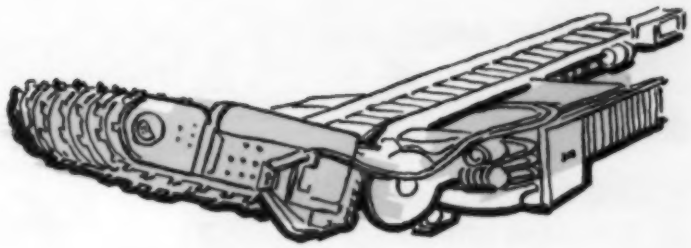


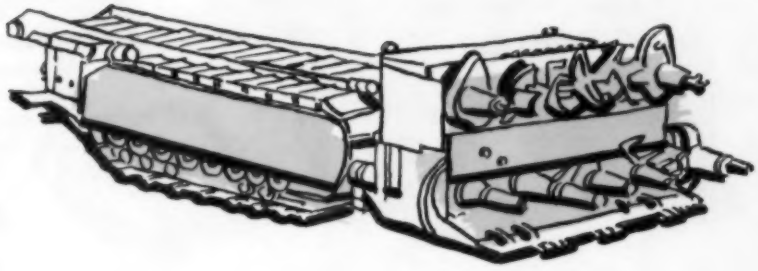
Cutter Bits

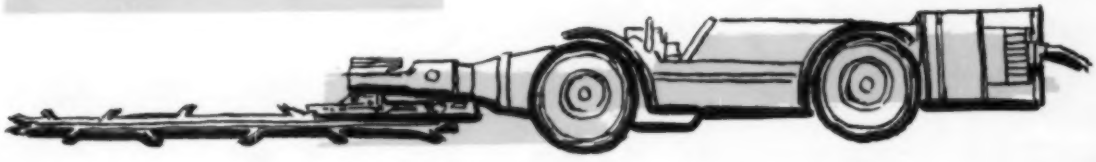
Bits for Auger Drilling

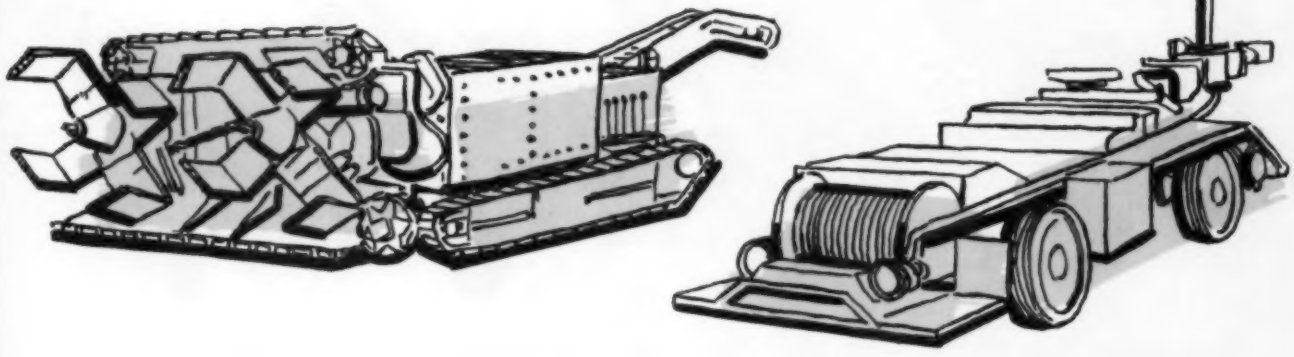
Bits for Roof Drilling

IT WILL PAY YOU TO TRY KENNAMETAL BITS IN YOUR MINING OPERATIONS









KENNAMETAL MINING TOOLS

for cutting... for drilling

no other carbide lasts so long . . . needs so little reconditioning . . . causes so little strain on equipment . . . costs so little per ton

Tool performance is measured best by the bit cost per ton. Cost is the end result of the quality of the bit. Kennametal bits are always of top uniform quality *because* Kennametal is able to maintain constant, rigid quality control of every step in the production of tungsten carbide bits from the moment ore is mined through each complex phase of refining the ore and of manufacturing the bits.

INDUSTRY AND **KENNAMETAL**
...Partners in Progress

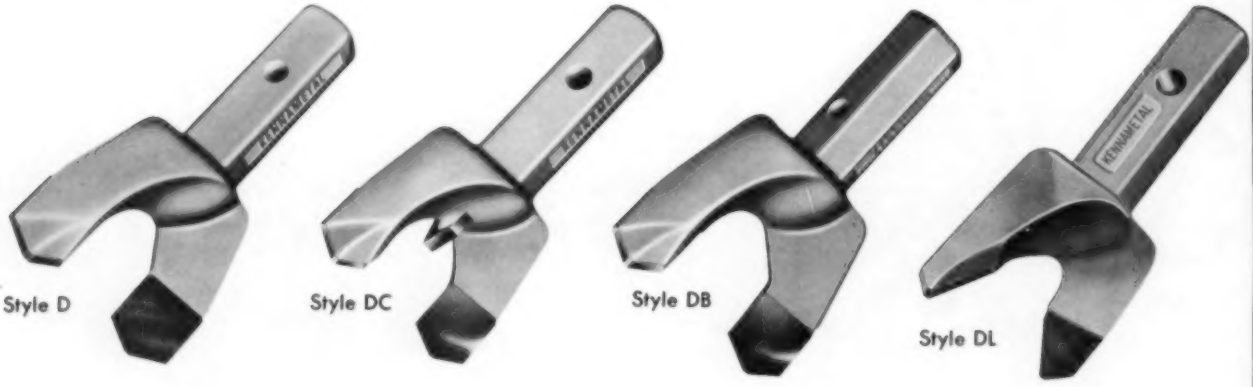
*Registered Trademark

AVAILABLE
A KENNAMETAL BIT FOR EVERY MINING NEED

• • • • • • • •

THERE IS A COMPLETE LINE OF KENNAMETAL CUTTER BITS, DRILL BITS, ROOF BITS, AUGERS, PINNING RODS, ACCESSORIES

Style U1 Style U7R Style U8 Style U7T Style U9R



Style D Style DC Style DB Style DL

Style FDH Style FDL Style PA

KENNAMETAL Cutter Bits

KENNAMETAL Mining-Machine BITS combine hard, cemented carbide cutting edges with a bit body of the highest quality steel, heat-treated to the correct hardness for machine operation. Special design and tough shank construction provide top coal cutting efficiency with long service life. Savings in production time, fewer bit changes, less machine maintenance add up to reduced cost per ton of coal. Ask your Kennametal Representative for reports from coal operators everywhere of top performance with Kennametal Cutter Bits.

Catalog Number	Dimensions			
	Gage	X	Y	L
U1	1½"	½"	1"	3½"
U4	1¾"	½"	1"	3½"
U7	1¾"	½"	1"	3½"
U7T		½"	1"	3½"
U8	1½"	½"	1"	3½"
U9	1⅝"	⅜"	1⅜"	3⅜"
U10	1¾"	½"	1"	3½"
U11	1½"	½"	1"	3½"
U10A	1¾"	½"	1"	3½"
U1R	1½"	½"	1"	3½"
U4R	1¾"	½"	1"	3½"
U6R	2½"	¾"	1⅛"	3½"
U7R	1¾"	½"	1"	3½"
U7RA	1¾"	½"	1"	3½"
U8R	1½"	½"	1"	3½"
U8RA	1½"	½"	1"	3½"
U9R	1⅝"	⅜"	1⅜"	3⅜"

KENNAMETAL Drill Bits

Designed for drilling both coal and rock, Kennametal Drill Bits provide long drilling life at low cost per ton. Even in successive layers of boney, clay, slate, shale and other hard impurities, the sintered carbide cutting edge withstands hard, tough service. And drilling can be continued for several shifts under average conditions, without time off for bit changing. Other features of Kennametal Drill Bits include fast chipping action, a rapid rate of penetration, and a smooth flow of cuttings.

Catalog Number	Dimensions		
	D	H	L
RD-1¼	1¼"	½" sq.	2"
RD-1⅜	1⅜"		
RD-1½	1½"		
RD-1⅝	1⅝"		
RDC-1⅝			
D-1¾	1¾"		
DC-1¾			
D-1⅞	1⅞"		
DC-1⅞			
DS-1⅞	1⅞"	⅝" sq.	1½"
DD-1⅞	1⅞"	½" sq.	2¼"
DDC-1⅞			
DD-2	2"		
DDC-2			
DD-2¼	2¼"	⅝" sq.	
DDC-2¼			

Catalog Number	Dimensions		
	D	H	L
DB-2¼	2¼"	1⅜" Hex.	2¼"
DD-2½	2½"	⅝" sq.	
DDC-2½			
DB-2½	2½"	1⅜" Hex.	
DBC-2½			
DB-2¾	2¾"	1⅜" Hex.	
DBC-2¾			
DB-3	3"	1⅜" Hex.	2¼"
DBC-3			
DBB-3	3"	1⅛" Hex.	3"
DBBC-3			

Styles DL and DBL are available in the same sizes and shank styles D and DB Bits, from 1¾" to 3".

KENNAMETAL Roof Drill Bits

The design of Kennametal Roof Drilling Bits and the selection of carbide grades for this service make possible the use of high thrust and torque to get holes through rock of various degrees of hardness and toughness without fracture of the cutting edges. Water ports are provided for cases where wet drilling is used. For more refractory work, Kennametal Rock Bits are supplied for use with stopers.

Catalog Number			Dimensions		
Style FDH	Style FDL	Style DK	D	H	L
FDH-1⅛	FDL-1⅛		1⅛"	½" sq.	2"
FDH-1⁵⁄₁₆	FDL-1⁵⁄₁₆		1⅜"		
FDH-1⅜	FDL-1⅜	DK-1⅜	1⅜"		
FDH-1⁷⁄₁₆	FDL-1⁷⁄₁₆		1⅞"		
FDH-1½	FDL-1½	DK-1½	1½"		
FDH-1⅝	FDL-1⅝	DK-1⅝	1⅝"		
FDH-1¾			1¾"		
FDH-1⅞			1⅞"		
FDBH-1⅞			1⅞"	⅝" sq.	2¼"
FDBH-2			2"		
FDBH-2¼			2¼"		
FDBH-2¼			2¼"	1⅜" Hex.	

KENNAMETAL SPECIALTIES AND ACCESSORIES

KENNAMETAL Pinning Rods

These Pinning Rods are of special design to make roof bolting more practical wherever standard drills are used. Generally, the rod shanks are of the twist type to fit regular Kennametal Drive Sockets, but square and other types are made for special applications.

Style PR

Style PRF

PR Rods with Twisted Shank	
Rod Length	Cat. No.
2′	PR 13-2
3′	PR 13-3
4′	PR 13-4
5′	PR 13-5
6′	PR 13-6

PRF Rods with 1⅛" Square Shank	
Rod Length	Cat. No.
2′	PRF 13-2
3′	PRF 13-3
4′	PRF 13-4
5′	PRF 13-5
6′	PRF 13-6

PRSB Rod (Extension) ½" Square Shank	
Rod Length	Cat. No.
1′	PRSB-1
2′	PRSB-2
3′	PRSB-3

Other lengths in 6" multiples available.
All types available with no scroll on request.

KENNAMETAL Augers

These augers are made of the highest quality steel available, giving them great strength and maximum resistance to bending. Life of the scroll is greatly increased by flame hardening during fabrication. Available styles of shanks: twist, threaded, and snap-button types. Smaller diameter augers have solid centers, while larger diameters are tubular.

Also Kennametal Sockets, Studs, Couplings and Adapters.

Snap-Button Shank Auger

Twisted Shank Auger

Threaded Shank Auger

Twist Shank Augers*

Auger Length	Cat.No. D=1⅞" C=½"	Cat.No. D=1½" C=½"	Cat.No. D=1⅜" Standard	Cat.No. C=⅝" H.Duty*	Cat.No. D=2" C=⅝"	Cat.No. D=2½" C=1⅜" Hex.
3 ft.	A13-3	A14-3	S16-3	S816-3	S20-3	H24-3
4 ft.	A13-4	A14-4	S16-4	S816-4	S20-4	H24-4
5 ft.	A13-5	A14-5	S16-5	S816-5	S20-5	H24-5
6 ft.	A13-6	A14-6	S16-6	S816-6	S20-6	H24-6
7 ft.	A13-7	A14-7	S16-7	S816-7	S20-7	H24-7
8 ft.	A13-8	A14-8	S16-8	S816-8	S20-8	H24-8
9 ft.		A14-9	S16-9	S816-9	S20-9	H24-9
10 ft.			S16-10	S816-10	S20-10	H24-10
Bit Sizes	RD-1⅜ RD-1½ FDH-1⅜ FDH-1⅝ RD-1½	FDH-1⅜ RD-1⅜ D-1¾ D-1⅞	DD-1⅜ DD-2	DD-1⅜ DD-2	D-2¼ D-2½	D8-2¾

*Special Heavy-Duty Auger for use with high-powered drills. Augers with threaded couplings for long hole drilling are obtainable in the 16, 20, and 24 series by using the auger number above and specifying Acme threads and connecting stud CSA, and shank TRCSA.

H Augers (Hexagonal Chuck) are available for D8 Bits.

Snap-Button Shank Augers

Cat. No. 3" long	Cat. No. 4" long	Dimensions D	Dimensions C
S813-3	S813-4	1⅜"	½" sq.
S814-3	S814-4	1½"	
S816-3	S816-4	1¾"	⅝" sq.
S820-3	S820-4	2"	
S824-3	S824-4	2½"	

Style BR Socket

Bits for Overburden Drilling

Kennametal Style FS Finger Bits provide exceptional stamina and speed in drilling large diameter holes in hard rock.

The Kennametal Style SD bit is a three-pronged bit used in sizes from 3¾ to 9-inch diameter for drilling holes to blast overburden and for other special uses. The UD bit, for similar applications, uses replaceable cutters.

Style FS

Style SD

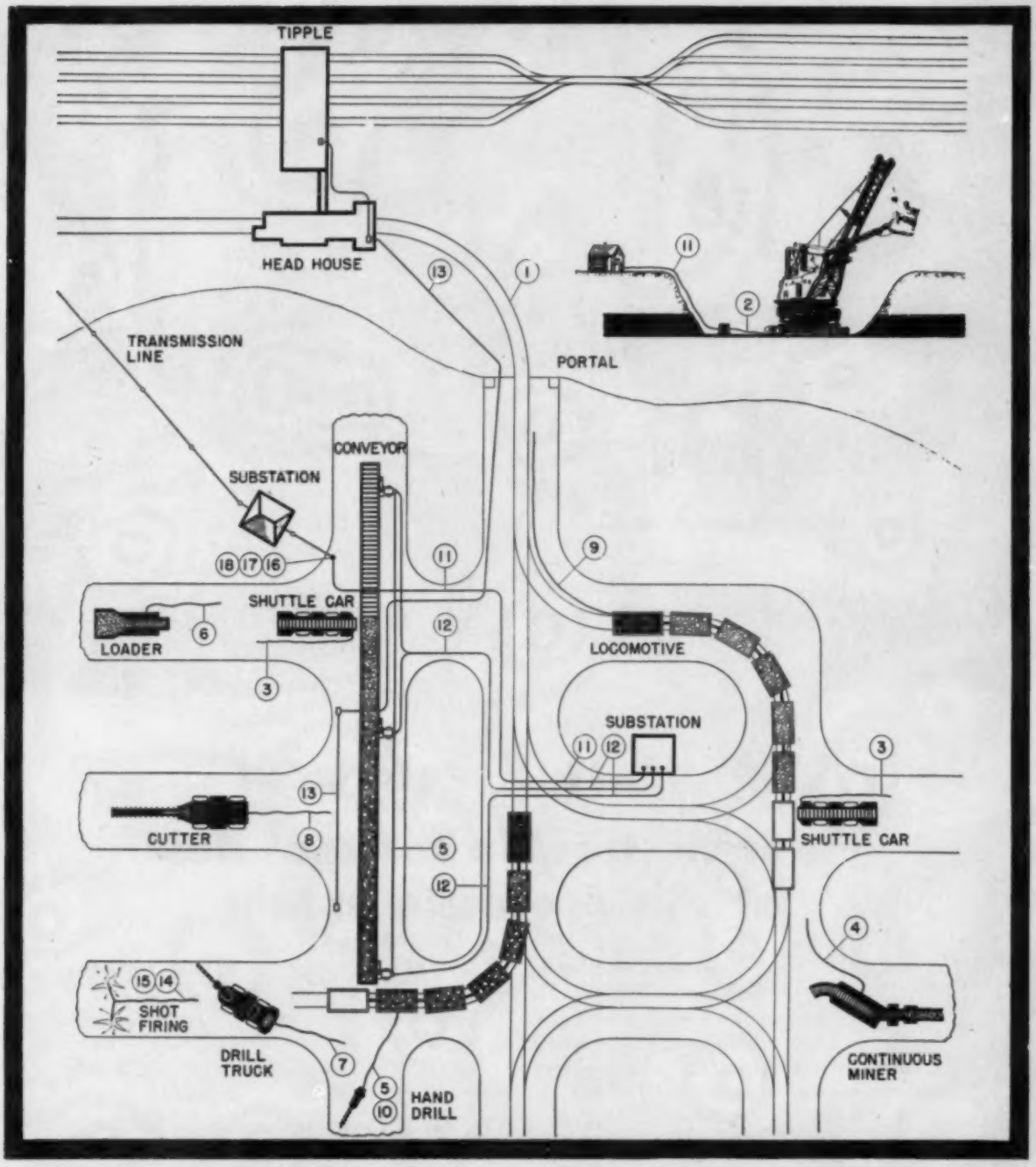
Style UD

INDUSTRY AND KENNAMETAL
...Partners in Progress

Mining Tool Division, Bedford, Pa.
General Offices and Main Plant, Latrobe, Pa.

Form BM 102

YOUR KENNAMETAL REPRESENTATIVE IS LISTED IN THE CLASSIFIED TELEPHONE DIRECTORY UNDER "MINING EQUIPMENT AND SUPPLIES"



Choose your mine cable from this page

It takes a miner to understand mine problems.

And at Anaconda we're miners ourselves—as well as the world's largest manufacturer of mine wire and cable.

From tipple to mine face there are Anaconda wires and cables—designed, made and tested by mine cable experts—for *every* job in the mechanized mine. These wires and cables have proved records of safety and economy in mines all over the world.

Ask your Anaconda Distributor for these Anaconda products:

1) Trolley wire; 2) Shovel cable; 3) Shuttle-car cable; 4) Continuous mining-machine cable; 5) Remote-control and heavy-duty drill cord; 6) Loader cable; 7) Drill-truck cable; 8) Mining-(cutting) machine cable; 9) Gathering-locomotive cable; 10) Hand-drill cord; 11) Mine-power cable; 12) Low-voltage power and feeder cable; 13) Telephone cable; 14) Shot-firing cord; 15) Blasting-cap wire; 16) Borehole and mineshaft cable; 17) Anaconda suspension unit for borehole cable; 18) Armored cable suspension unit.

For more information, call or write Anaconda Wire & Cable Company, 25 Broadway, New York 4, N. Y. 5456

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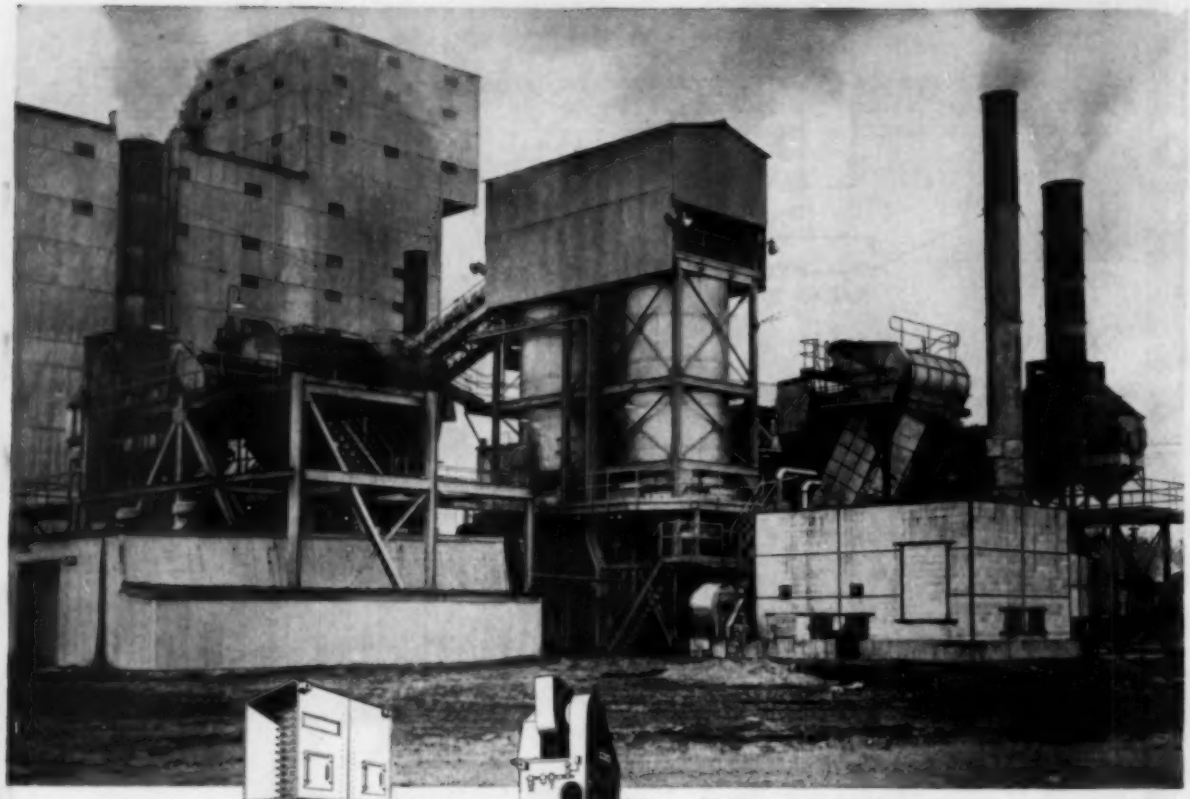
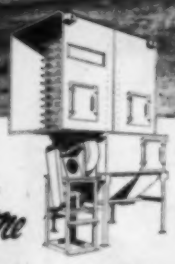




AMERclone and ROTO-CLONE

—double trouble for coal dust at this processing plant

AAF's famous coal dust duo—AMERclone and Type N ROTO-CLONE—snuff out the dust threat from these multi-louver dryers before it has chance to become a nuisance. The AMERclone dry centrifugal serves as the pre-cleaner and reclaims valuable material. The tiny particles that get by are instantly snatched up by the wet-collecting Type N ROTO-CLONE. Thus, a potential air pollution problem is turned into harmless sludge.

AAF offers *all kinds* of dust collectors for *all kinds* of coal processing dust problems. No matter what the source—bunkers, screens, transfer points, crushers and breakers, silo venting, cleaning tables, rotary car dumps or air tables—there's an AAF dust control unit to do the job . . . efficiently and economically.

For complete information on the AMERclone and Type N ROTO-CLONE, call your local American Air Filter representative or write direct for AMERclone Bulletin 291 and Type N Bulletin 277.

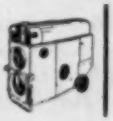
AAF Dust Control Equipment

AAF Filters and Precipitators

American Air Filter
COMPANY, INC.
267 Central Avenue, Louisville 8, Kentucky
American Air Filter of Canada, Ltd., Montreal, P.Q.

— BETTER AIR IS OUR BUSINESS —

Herman Nelson Portable Heaters



Illinois Heating Specialties

teeth that really dig

A GOOD TEAM

H & L RAPID RIPPER

- Narrow sharp replaceable point penetrates in hard, compacted ground
- Lightweight — Easy to handle — One man can attach or detach

BULLDOZER CORNER ADAPTERS

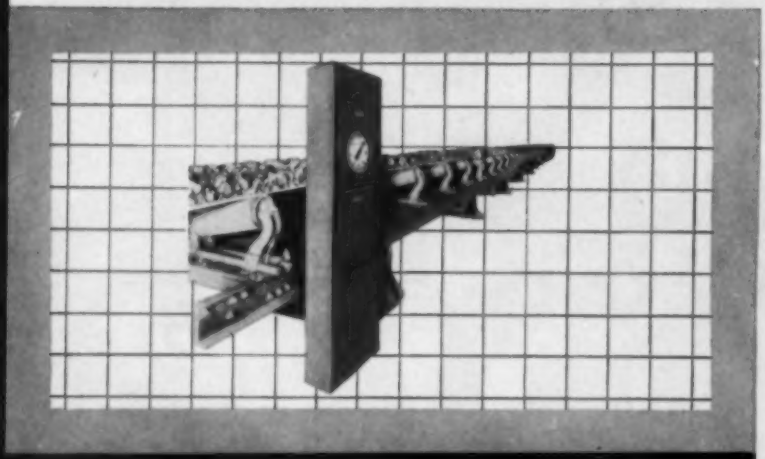
- Increases efficiency of Bulldozer — More material moved with less power
- Corner points stay sharp — Eliminates round corners

FOR ALL BULLDOZER MAKES AND MODELS

H & L TOOTH COMPANY

1540 SOUTH GREENWOOD AVE. MONTEBELLO, CALIF.

COSTS DOWN! PRODUCTION UP!



... WITH BUILDERS Conveyoflo

CONVEYOFLO Meter is a precision unit of rugged construction for accurate totalization of all belt-conveyed materials. With the addition of a controller, a preset rate of delivery will be maintained. With the addition of a pneumatic transmitter, it can pace proportionally the delivery from auxiliary feeders in automatic processing systems. Conveyoflo comes as a complete unit including conveyor, drive, and weighing mechanism . . . or can be installed in your present conveyor lines. Here is thoroughly reliable, service-proven equipment.

FEATURES

- ACCURACY — within plus or minus 0.4 of 1% of full scale load over a 10:1 range.
- CONTINUOUS INTEGRATION — automatically compensates for variations in belt speed . . . provides accurate response to rapid load variations.
- OVERLOAD PROTECTION — weighing element and calibration not subject to damage by overloading.
- PNEUMATIC OPERATION — inherently explosion-proof.
- COMPACT — weight sensing mechanism completely contained within conveyor structure. Panel located above or below conveyor as desired.

ACT TODAY!

Bulletin 550-H4A gives complete data on Conveyoflo operation, accuracy, totalizer head, weigh spans, etc. Request your copy from **Builders-Providence, Inc., 395** Harris Ave., Providence, R. I. . . . division of

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DIVISION OF
B-I-F INDUSTRIES METERS FEEDERS CONTROLS

What's New in Stripping Or Augering?

No matter what your particular interest, you'll find *Coal Age's* monthly issues keep you right on top of the new ideas, improved methods and better equipment continually turning up.

Bigger overburden drills, gigantic shovels, new blasting agents, new-type augers—if it's important, you'll see the story in *Coal Age* first.

Use the stripping section in this Guidebook (pages 102-133) for the practical working manual it's designed to be, but watch *Coal Age* each month for the very latest developments.

You may find them in *Coal Age's* regular mine descriptive articles, in special stripping and augering studies, in meeting reports, or in the "Operating Ideas" and "Equipment News" sections.

Stripping is one of the 21 major mining functions *Coal Age* covers regularly and consistently to help you make your job better.

COAL AGE

Mine Management's Leading Idea Source Since 1911

How **YOU CAN EQUAL** these Drilling Records:

What the owners of **REICH** Drills are doing:

"80% more hole drilled by Reich 650 in shale and medium sandstone, than by another hydraulic powered rotary of same rated capacity."

"Weighing 6½ tons less than a crawler rotary that cost almost twice as much, Reich 650 drilled 7⅜" holes approximately as fast in hard tough sandstone."

"238 ft. per hour in medium sandstone and shale drilled by Reich 750 in 3¼-hour test, 40 to 50 ft. holes— including all moves. 450,000 ft. of hole in 9 months, single shift."

"14.3 ft. per hour in very hard trap rock, 6⅝-inch hole, drilled by Reich with down-the-hole hammer. Competing drill 11.9 ft. of 6½-inch hole."

"Very hard rock, Reich 650 with 6⅝-inch down-the-hole tool drilled 28 ft. in 31 min. Other rig with 6-inch tool, 29½ ft. in 60 min."

"In one month, 3,106 ft. with Reich; our other rig in same material, 750 ft."

"We drilled 9,049 ft. in 85 days, 8 hrs. a day with Reich; with churn drill, 2,806 ft."

(Full details of the above cases— and many more— sent on request)

You must have—*to equal the above production— these improvements . . .*

Infinitely variable speed of drill rotation, so that your operator can instantly hit the exactly right speed for every stratum. Any drill rig with only two or three rotation speeds *works at wrong speed most of the time.* The Reich makes far more hole— with lower bit cost, because of correct speed and pressure.

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Quickest stem loading. The Reich's faster stem loading saves time and money on every hole. Less than a minute to add a drill stem, with either the Barrel Loader or Hydraulic Loading Arm— compare with the time needed on other drill rigs.

Steadiest service— that you get from the drill that's built so much stronger that *you have to see it to believe it.* Experience has shown us where extra strength is needed— and we put it there. **Compare** Pumps, Motors, Gears, Frames, other vital parts— much sturdier, saving you valuable drilling time and many dollars of upkeep expense.

See the *Better Design* that's back of the

REICH Drill's

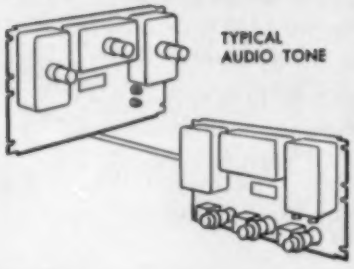
Bigger Production

Write for new Bulletin: "Drilling Records," to REICH BROS. MFG. CO., 1439 Ash Street, Terre Haute, Indiana

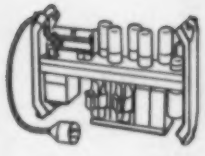
COMMUNICATION AND CONTROL for Modern Mines

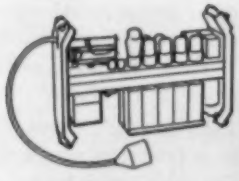
USE YOUR POWER LINES OR ONLY ONE PAIR OF WIRES!

TYPICAL AUDIO TONE



TYPICAL CARRIER CONTROL





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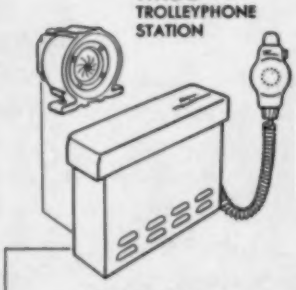
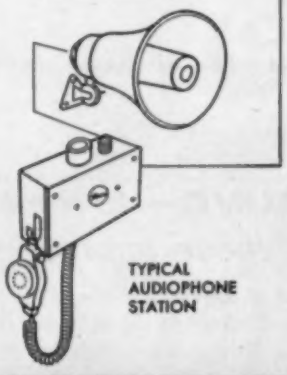
Small Units—Easy to Install

TYPICAL TROLLEYPHONE STATION



MAY BE COUPLED IN ONE NETWORK



TYPICAL AUDIOPHONE STATION

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ASK FOR NAME OF NEAREST FEMCO SALES ENGINEER FOR CONTROLS

UNderhill 3-3200 **Femco, Inc.** IRWIN, PA.

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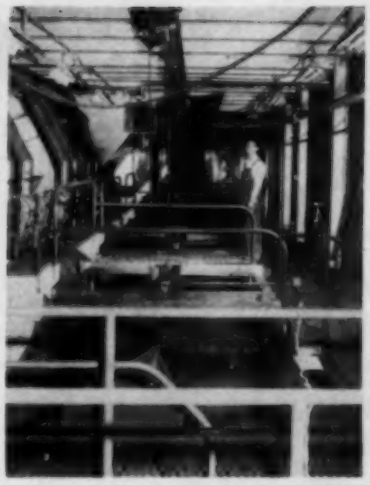


How You Can Visit New Coal Plants Regularly

Coal Age readers get personally conducted tours of the industry's newest and most efficient preparation plants without moving from their chair.

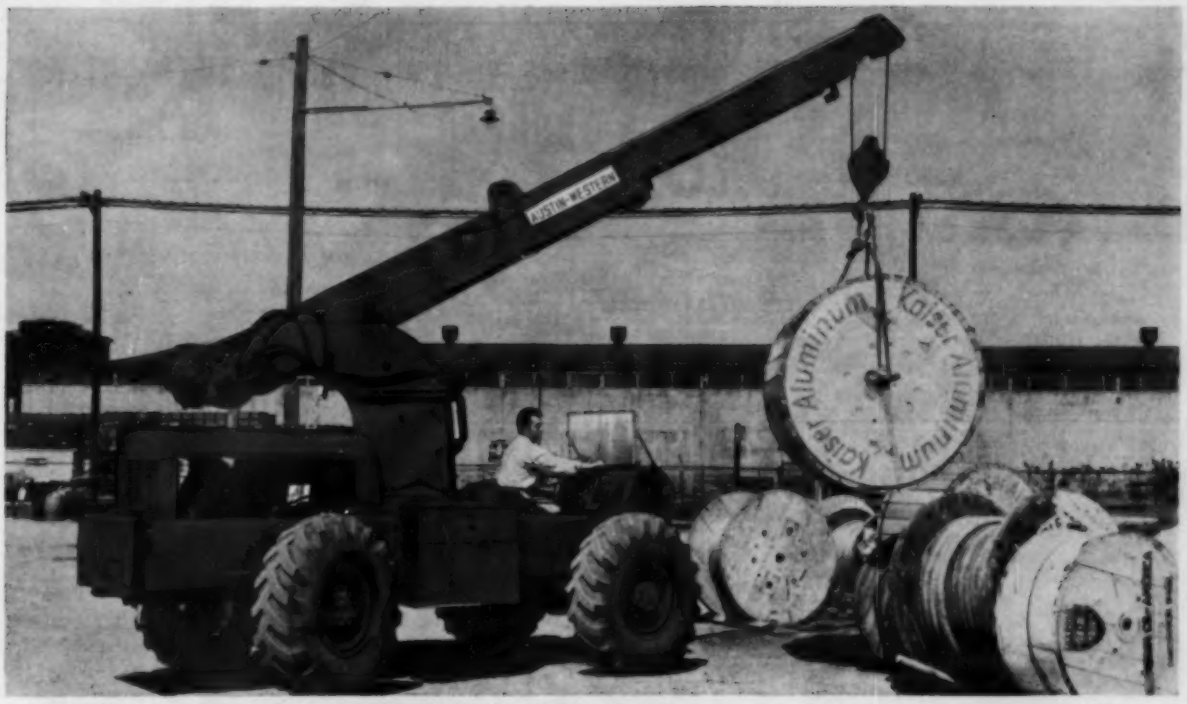
In *Coal Age's* fast-reading mine descriptive articles, our editors highlight significant plant features, emphasize the why as well as the how of new ideas and unusual equipment applications. You get in a few minutes the essential facts and useful information it would take hours to obtain in a personal visit, if you could spare the time from your job.

The preparation section in this Guidebook (pages 132-159) will give you a thorough briefing on methods and equipment in current use at hundreds of efficient mines. *Coal Age's* monthly issues will keep you up to the minute on new plants and important technical developments.

Coal preparation is one of the 21 major mining functions *Coal Age* covers regularly and consistently, to help you make your job better.

COAL AGE

Mine Management's Leading Idea Source Since 1911



CUT MAINTENANCE COSTS WITH AUSTIN-WESTERN

A-W Hydraulic Crane for faster precision lifting

This is the most versatile machine yet designed for all-around lifting jobs. Carries loads up to 5 tons, swings, lowers, and spots them into exact position. All boom movements—raising, lowering, swinging and telescoping—have finger-tip hydraulic controls that can be used individually or simultaneously. All-wheel steer and a 15 ft. 8 in. turning radius take it in and out of tight spots, indoors and out. All-wheel drive and oversize tires make easy going of railroad tracks, rough or snowy terrain. Can haul and spot cars on your sidings, yard or pit. Usually pays for itself in the first year by speeding repair jobs, reducing downtime, and saving labor.

A-W Motor Grader for the tough road jobs

A-W Motor Graders with all-wheel drive give you 30% more power where it counts—at the blade—than ordinary graders with dead front ends. Building and maintaining access and haul roads under conditions like those shown at left demand the kind of tractive effort that only all-wheel drive can give. With a bulldozer attachment (shown at left), A-W's power and ruggedness often save the cost of a tractor-bulldozer.

Get complete information from your A-W distributor or write direct

Power Graders • Motor Sweepers • Road Rollers • Hydraulic Cranes

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Typical Installation on Main Haulage

- Rugged.
- Low in Cost.
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- Increases Production.

"Cheatham Switch"

TRACK SWITCH THROWER ELECTRICALLY OPERATED

This modern track switch is thrown swiftly and safely by motorman as they sit in their cabs. It saves time and money, and is fool-proof and dependable!

Over 50 years experience manufacturing

ELECTRIC TRACK SWITCHES and DERAILS

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NUSSCO AUTOMATIC BLOCK SIGNALS FOR MINES

Save Trip Time on Main Haulage
Prevent Collisions

A two wire cable connects two or more signals together into one block. Only one signal can show proceed on the entrance of a trip, all other signals show stop.

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Help in Buying . . . Who Makes It . . . Where Are They

A COMPLETE CROSS-SECTION of the modern equipment, materials and services offered by manufacturers and service organizations is presented in this 1957 Mining Guidebook issue of *Coal Age*.

The Buying Directory Section is designed to help you in three major ways:

1. If you need equipment, materials and services not previously used . . .

2. If you are interested in additional sources of equipment, materials and services . . .

3. If you are developing a new idea in production, preparation and safety and want to see what's available for carrying it out . . .

Check the Buying Directory beginning on p 289. Find the product in the alphabetical list. Under it will appear the names of the key manufacturers, with those advertising in this issue indicated by black-faced type.

Consult the manufacturers' advertisements in this issue for information on specific products, materials and services. To locate the local source of supply nearest you, check the list of advertisers district sales offices and distributors provided at the end of this issue.

How are your **ROOF BOLTS holding?**

U. S. Pat. 2464152

INDICATOR FLAT
8000 lbs. tension—yellow indicator

INDICATOR UP
Tension has been lost

FOR GREATER SAFETY INSTALL
AMERICAN VISUAL TENSION INDICATORS

TENSION, not foot lbs.-torque, gives the true indication when roof bolts are properly installed and stressed. Tension indicators show when bolts are properly installed and also when tension is lost.

TENSION INDICATORS SHOW:
You are anchored in good strata,
The roof bolting equipment is operating properly,
Your roof bolts are uniformly stressed.

ORDER DESIRED TENSION FOR YOUR ROOF CONDITION: #T800 Yellow - indicates 8000 lbs. tension; #W600 White indicates 6000 lbs. tension. Write for complete information.

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If you need effective, highly readable, smartly illustrated company literature (booklets, pamphlets, manuals) to display your products, inform the public of your operations, attract key personnel to your plant, train employees, and perform any of the other communicative functions that are vital to your business . . .

THIS IS YOUR ANSWER

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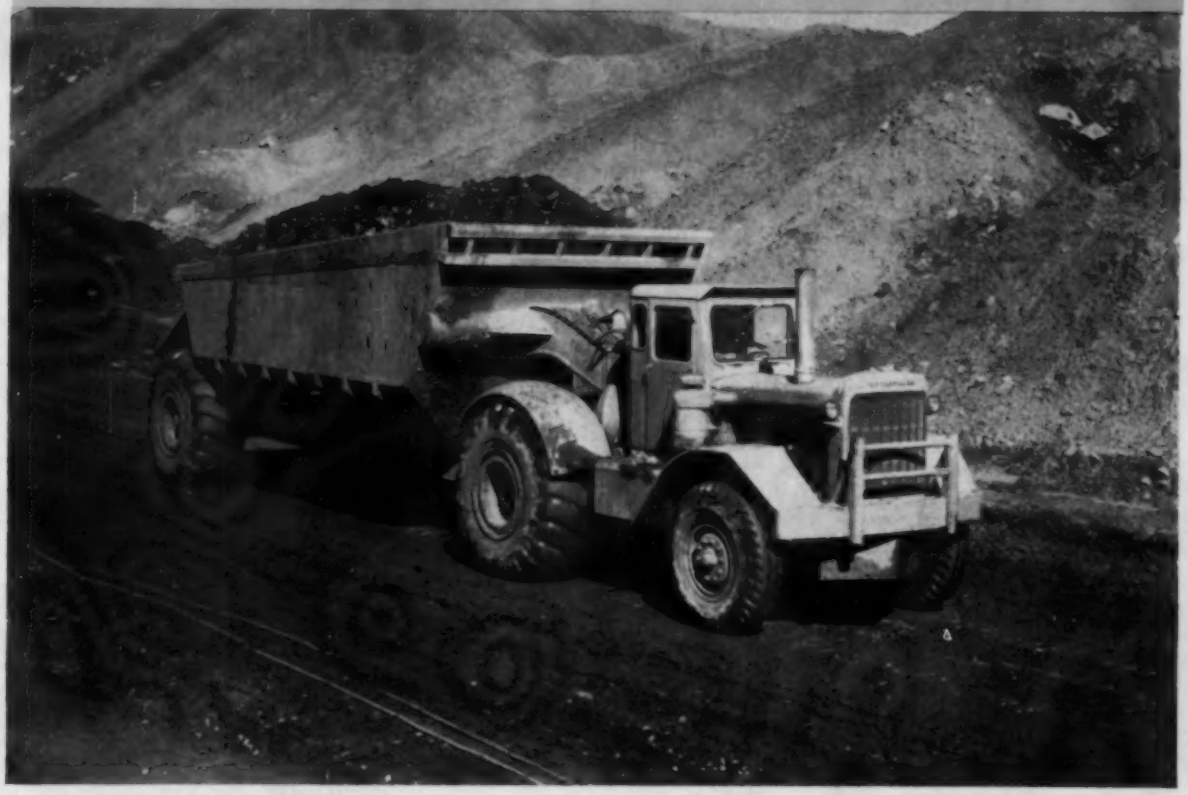

ATHEY-CAT COAL HAULERS

United Electric Coal Co. is one of America's top coal producers. They also know their coal hauling equipment. That's why they operate Athey-Cat PH20-DW20 Coal Haulers in their Cuba (Illinois) mine.

The PH20-DW20 is the right choice for any coal hauling operation. It has a big 62 cu. yd. capacity, but is 8,000 to 10,000 lbs. lighter than most haulers of similar capacity. Good design and the use of premium quality steels make possible an almost 2 to 1 ratio of payload to unit weight.

The PH20-DW20 team is fast, too, with speeds up to 32 MPH. With a turning diameter of 38' 4", it is highly maneuverable — works well on narrow benches or in close quarters. Dumping is easy and fast with a dependable hydraulic-actuated bottom dump mechanism. Best of all, the PH20-DW20 team is designed for many years of profitable service.

Take advantage of the speed, strength and capacity of the PH20-DW20 team. Put them to work in your mine. Your Athey-Caterpillar dealer will be happy to show you proof of their superiority. See him soon.

Athey

ATHEY PRODUCTS CORPORATION
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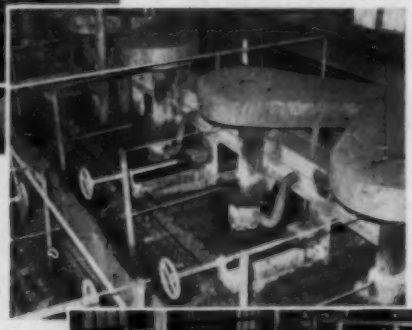
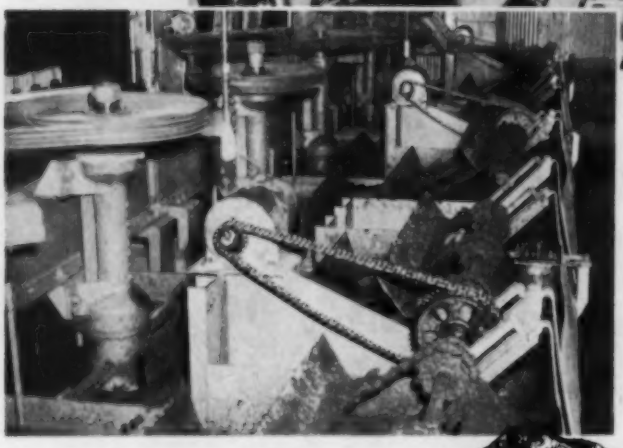
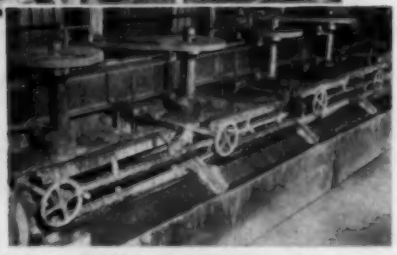
Over 95% of ALL COAL FLOTATION PLANTS IN U. S. Use ...

DENVER "Sub-A" FLOTATION







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DENVER-DILLON Vibrating SCREENS

For floor or suspension installation. "True-circle" motion. Screens in stock for quick delivery. Sizes from 1'x 3' to 6'x 14'.

DENVER Disc FILTER

Extra large filter area is available in a limited space. Available with agitator in tank. Sizes to 9'.

DENVER Automatic SAMPLERS

Simple, low-cost, dependable and accurate unit. Few moving parts, no maintenance. Standard duty 16", 21", 24" and 30" samplers and cutters in stock.

DENVER Spiral Rake THICKENER

A simple heavy-duty rake and settling unit for the separation of solids from liquid. Sizes to 125'.

OTHER ITEMS: Ore Testing, Mill Design, Pilot Plant and Laboratory Equipment, Jigs, Tables, Hydra Classifiers, Power Plants, Elevators, Conveyors, Reagent and Ore Feeders, Pulp Distributors, Dryers, Ore Cars, Tanks, Placer Equipment, Cyanide and Leaching Equipment.

"The firm that makes its friends happier, healthier and wealthier"

DENVER EQUIPMENT COMPANY

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DENVER 17, COLORADO
PHONE: CHERRY 4-4466

powered by White's Superior Diesel

Manitowoc 4500 cuts Ohio Stripper's cost 20%

Careful equipment selection is paying off for Terramana Brothers Coal Co., Steubenville, Ohio. For digging into 70 feet of overburden, they chose a Manitowoc 4500 shovel . . . and wisely specified the rugged, dependable White Superior Diesel for power. According to Terramana Brothers, this perfect combination greatly increased production and cut operating costs . . . resulting in more than 20% overall savings!

The big 4-yd. rig with a 60-ft. boom and a 45-ft. stick works two 10-hour shifts daily, powering away almost 400 yards per hour. The high torque Superior engine provides more line muscle . . . it pulls a full dipper with little effort. Under light load, it enables swings at top speed without surging. The faster and smoother cycle increases production!

Many cost saving advantages of Superior's design simplicity also contribute greatly to this economy. Easy accessibility of internal parts speeds servicing in close quarters. Down-time is practically eliminated because maintenance and repairs are reduced to a minimum. Many case histories show 35,000 engine hours with no major replacement parts required. Superior's first valve job usually comes due long after other engines would be completely replaced! Highly developed, open chamber combustion achieves optimum air and fuel mixture, low fuel consumption and easy starting. Precision construction throughout reduces wear and assures lowest lube oil consumption.

Specify White's Superior Diesel on your next new shovel or when you're re-powering. Power ranges from 225 to 2150 B.H.P. for all types of service. *Write for complete information today.*

White Diesel

WHITE DIESEL ENGINE DIVISION
THE WHITE MOTOR COMPANY

Plant and General Offices: Springfield, Ohio

Transite Mine Service Pipe

Stubbornly resists corrosion

MINE OWNERS AND OPERATORS have found from years of experience that Transite® Mine Service Pipe protects against frequent replacements due to corrosion.

Made of asbestos and cement, Transite is highly corrosion-resistant *all the way through*. It is strong and durable yet light in weight, easy to handle. Its Ring-Tite® couplings form joints that are flexible yet stay tight through the years. This flexibility permits conformance to the curves so frequently met in mine gangways.

For further information about Transite Mine Service Pipe and its use for mine drainage, water supply or other service write for Brochure TR51-A, Johns-Manville, Box 14, New York 16, N.Y.

Johns-Manville

TRANSITE Mine Service Pipe

WITH THE RING-TITE COUPLING

Remember this

MERRICK

guarantees

ACCURATE WEIGHT

wherever you

FEED OR CONVEY

Remarkable FEEDOWEIGHT!

A self-contained automatic conveyor scale. Has automatic gate for feed rate control. Feed regulator operates gate, without restraint on scale beam. Feeds bulk material BY WEIGHT; automatically totalizes weight of materials fed. Simple operation. Slow moving parts for long life. Easy to install, maintain.

WEIGHS AND TOTALIZES WHILE CONVEYOR IS RUNNING

WEIGHTOMETER

Gives a continuous automatic, accurate totalized weight record while material is in motion on conveyor. It weighs without interrupting conveyor service. Used with any size belt conveyor, horizontal or inclined. Guarantees an accurate and dependable constant check on production of raw and washed coal, ore, etc.

MERRICK SCALE MFG. CO.

Engineers and Mfrs. of Automatic Weighing Equipment

PASSAIC, N. J.

This modern plant processes over 100 tons per hour of ¾" x 0" raw coal feed. Specifications call for clean coal of not more than 5½% ash. Surface moisture is reduced to under 7½% without heat drying.

Complete Fine Coal Washing and Thermal Drying Plant built by H & P to complement existing coarse coal preparation plant. ¾" x 0" raw coal is fed at the rate of 140 tons per hour. The clean coal averages 4.75% ash and has a surface moisture of 3%. Plant bleed under normal operating conditions has been 50 GPM at less than ½% solids from the refuse circuit.

The one new Fine Coal Washing Method—

The HEYL & PATTERSON Circuit

A scientifically designed Fine Coal Washing and Water Clarification Plant using the "H & P Circuit" relies on the proven combination of H & P Cyclones, Reineveld Centrifuges, and the new Fluid Bed Dryer for superior performance and low-cost operation.

When you talk to an H & P sales engineer about your fine coal recovery problems, he is backed by the experience of our research department which developed the H & P Self-balancing Circuit after years of painstaking field and laboratory tests.

Since 1891, Heyl & Patterson has designed and built many coal preparation plants. We have adhered to the firmly established basic idea that the exacting requirements of economical coal preparation demand careful engineering analysis and development of flowsheets. These are tailor-made for your specific requirements, to permit maximum recovery and to comply with stream pollution legislation. *Heyl & Patterson has given the coal industry the correct facilities for preparing coal for specific markets, assuring high standards of accuracy and uniformity for its customers.*

The newest development in this challenging field is the application of the H & P Circuit to Fine Coal Washing and Water Clarification Plants. Many of these plants are now in service and their daily operating records confirm these advantages:

- Lower initial investment
- Lower operating and maintenance cost
- Full 100% recovery of all solids reporting from the clean coal discharge of the washing equipment
- Closed water circuit operation where desired

You, too, can enjoy these and other advantages if the layout and design of your Preparation Plant are the result of proper design and equipment application by H & P specialists.

Eliminating all guesswork is the surest way to customer satisfaction. Let us prove our point.

Send for informative brochure on Fine Coal Jig, Reineveld Fine Coal Centrifuge, H & P Cyclones or general Coal Preparation Plant Bulletin.

When Experience Counts . . . Count on Heyl & Patterson!

Heyl & Patterson INC.

70 YEARS OF SERVICE

55 FORT PITT BLVD. • PITTSBURGH 22, PA.

BRADFORD COAL BREAKERS
CAR DUMPERS
CONVEYING SYSTEMS
REINEVELD CENTRIFUGAL DRYERS
THERMAL DRYERS
WET CYCLONES

Quick connection for better blasting...

AUSTIN DETONATING FUSE and CONNECTORS

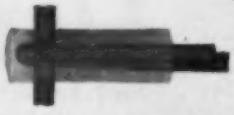
Effective blasting depends upon use of a powerful detonating fuse with proper connection between trunk and lead lines.

That explains why successful strip mines and quarries rely on Austin Detonating Fuse and plastic Connectors. This combination provides a quick hook-up of high strength fuse that won't slip, slide or lose contact in any weather or under any job condition. It also eliminates tying of knots and the resultant possibility of their becoming untied.

Blasting goes according to schedule with Austin Detonating Fuse, for it possesses more than enough power to initiate the entire charge in every hole. Protected with a waterproof covering, it is tough, but flexible . . . won't chip, peel or crack while being laid. It's insensitive to shock, abrasion and stray electrical currents.

AA-4482

First, thread fuse from shot hole through length of connector. Then, press the trunk line into the grooved slots.



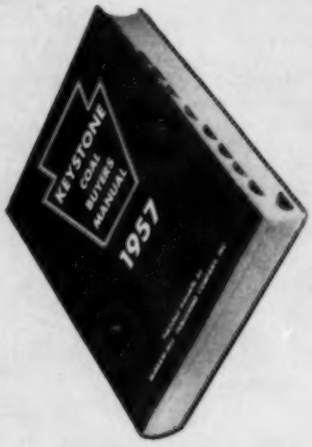
Next, return the branch line through the end of the connector on the other side of the trunk line. Pull both ends of branch line tight for positive connection.

USED IN AUSTIN SINCE 1833 EVER

AUSTIN
POWDER COMPANY
CLEVELAND 13, OHIO

explosives ◆ permissible dynamites ◆ mine tools
◆ detonating fuse ◆ AP drill heads ◆ Akremite ◆ primers

Recommended for Buyers, Sellers and Producers of Coal



1957 KEYSTONE COAL BUYERS MANUAL

AUTHENTIC, UP-TO-DATE DATA ON
Coal Sales Organizations
Characteristics of Seams
Coal Operating Companies
Trade Names
Cleaning Plants
Coal Mines
Electric Utility Plants
Coke Plants

DETAILED MINE DATA INCLUDES:

Location, by town, county, state, railroad. Kind of opening seam and thickness. Cleaning, drying and preparation equipment, sizes shipped. Daily capacity, annual productionfi life expectancy. Indices by mines, companies, sales executives, sales offices, operation executives.

Each Annual Edition includes 33⅓% Change in Detailed Listings on Companies and Mines.

1957 Edition Now Available at $35 per copy. Sent on approval.

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COAL BUYERS MANUAL
A COAL AGE Affiliate
330 West 42nd Street
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"Pay-Off" at the hopper!

DART'S

Greater Payload Lowers Haulage Costs

Daily performance charts kept on 50 ton DART coal hauler operations in major open pit mines consistently prove greater availability — reduced maintenance costs — reduced haulage costs. The new DART 60-SBDT carries 70 cubic yards (struck) — a 60 ton payload. Its performance figures reflect even lower haulage costs. It is powered with a 400 H.P. diesel and torque converter providing smooth operation and increased traction. The 80,000# tubular hitch with sealed oil reservoir eliminates periodic lubrication.

BEFORE AND AFTER USING DARTS
IN A TYPICAL COAL STRIP MINE

	30 OLD smaller trucks working two shifts	10 NEW 50 ton DARTS working one shift
Truck Operation	4.5c	2.1c
Truck Maintenance	6.2c	2.3c
Road Maintenance	1.9c	1.5c
Total per ton/mile	12.6c	5.9c

25 TON DART COB HAULER

The workhorse of DART'S end-dump line. Dart Model 25SL can be equipped with 300-335 H.P. diesel with torque converter. Body capacity and other features are optional to meet specific haulage requirements.

HEAVY DUTY TRUCKS EXCLUSIVELY SINCE 1903

DART TONNAGE ENGINEERED TRUCKS

Kansas City 8, Missouri

SUBSIDIARY OF THE CARLISLE CORPORATION

D-137

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CONTINUOUS CENTRIFUGAL COAL DRYERS

A FINE DRYER...PLUS SERVICE

The C.M.I. Dryer will do a magnificent job, reducing 35% moisture content in coal to less than 5%.
A whale for work; amazing drying capacity.
Our engineers are available to render prompt service whenever and wherever needed.

A FINE DRYER...PLUS SERVICE

The C.M.I. Dryer will also prove its worth as a real profit-producer by recovering marketable coal from your slurry ponds.
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This is a 100% Home (U.S.A.) Industry.
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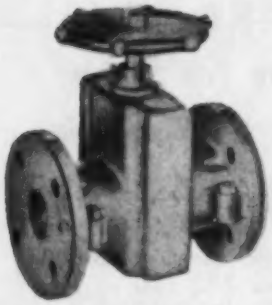
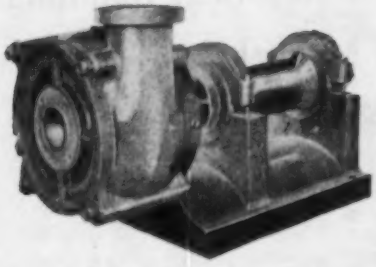


VALVES



PUMPS

TABLECOVER

BALL MILL FEED SCOOPS

PIPING

IN MINING EVERYWHERE WHAT ELSE BUT LINATEX LASTS LONGER AND COSTS LESS

... DEFIES ABRASION AND CORROSION

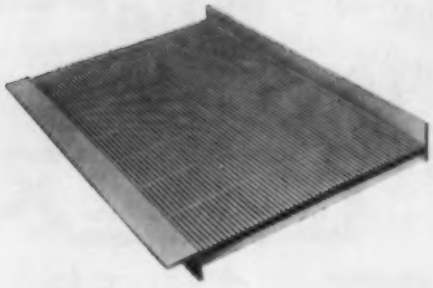
Re-examine your operations, and chances are you'll find one or more spots where added protection from abrasion and corrosion with Linatex (a specially processed rubber) can cut costs.

If you have an idea where Linatex can help you, merely send us your inquiry. We will send you all available information – and, if necessary, conduct special tests without obligation.

LINATEX CORPORATION OF AMERICA

Vernon Ave., Rockville, Conn.

GIVES COAL



A REAL CLEAN SCREEN!

You keep coal quality high when you give it a Hendrick Wedge Slot screening! Hendrick Wedge Slot has the kind of small openings that assure fine screening yet affords far greater draining and screening capacity. Profile bars are "precision shaped" to maintain uniform width of slot openings the entire length of the screen as wear progresses. For details on the Hendrick Wedge Slot Screen best suited to afford long life under your specific operating conditions, write Hendrick today.

Hendrick MANUFACTURING COMPANY
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Perforated Metal • Perforated Metal Screens • Wedge-Slot Screens • Hendrick Wedge Wire Screens • Architectural Grilles • Mitco Open Steel Flooring • Shur-Site Treads • Armorgrids • Hydro Dehazers • Petrochemical Column Internals

Are You Seeking Better Results in

PREPARATION?

First check through pages 132-159 of this Guidebook for the latest developments in:

- Raw-Coal Handling
- Crushing
- Sizing
- Washing
- Air Cleaning
- Dewatering, Drying
- Mixing, Blending
- Dustproofing
- Raw and Clean Coal Storage
- Loading
- Sludge Recovery
- Refuse Disposal

Who Makes What... And Where?

TO LOCATE MANUFACTURERS of equipment, materials and supplies used in coal preparation, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. Their district sales offices and distributors near you are listed in the Distributors' Index at the end of this issue. You'll find more useful information in their advertisements.

COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE

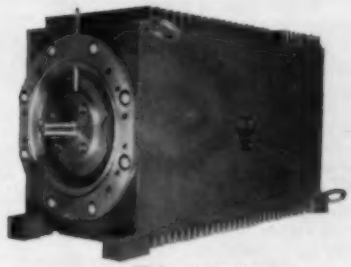
An established annual service for all COAL AGE subscribers

When safety comes first . . .

YOU CAN BE SURE...IF IT'S Westinghouse

drive motors

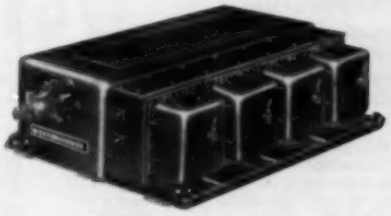
Explosion proof heavy duty type SK motor for service underground. Built for continuous mining machines or to drive coal conveyors or loaders. 50 hp, 230 or 500 volts d-c, 1150 rpm. Class B insulation (modified class H insulation available). 100°C rise over 20°C ambient. Continuous duty. Totally enclosed non-ventilated. Approved by U.S. Bureau of Mines for underground use. Frame 111.14SK.



type SK d-c mine motor

nitrogen-filled power center

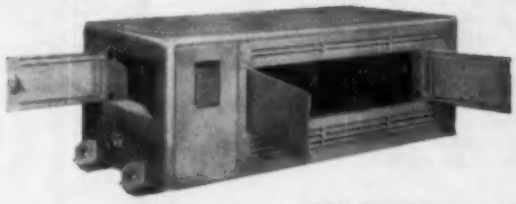
This portable mine power center is nitrogen filled and safe for underground service in explosive atmospheres. Approved by Pennsylvania Department of Mines. Only 25½ inches high, light in weight, and easily portable on its skid mounting. Contains no liquids. Core and coils of transformer are hermetically sealed. Explosion-proof type AB De-ion circuit breakers are included. Ratings: 75 to 500 kva; three phase; 60 cycles; high voltage, 2400 to 7200; low voltage, 240Y or 480Y with kva taps. Connections are quickly and easily made at new locations.



solid steel base with pulling eyes

ventilated power center

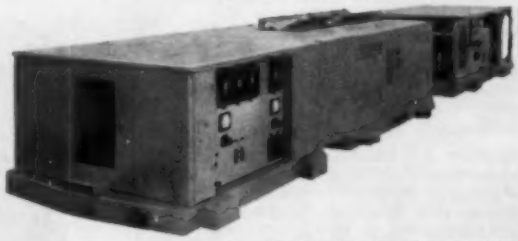
Ventilated dry-type mine power centers are compact units designed for dry underground mining service. Power center consists of—high voltage section, the transformer, and low voltage breakers. Transformer is of the non-explosive, fire-resistant, air-insulated dry-type construction. Class B insulation materials. Case is arranged for direct air cooling by means of louvers. Entire unit is mounted on skids and can be pulled along mine floor. A dolly with adjustable wheels is available for track use. Size 36″ high, 45″ wide. Ratings: 75 to 500 kva, three phase, 60 cycles, 2400 or 4160 volts on the primary, 240 or 480 volts on the secondary, and 240 volt single phase lighting circuit.



view of skid mounted unit from low-voltage end

ignitron rectifier substations

Westinghouse ignitron substations offer many advantages and increased efficiency in mining service over m-g sets for power conversion. These substations take high voltage a-c power from the incoming main line, transform it down to usable voltage, convert it to d-c, and send it off to the d-c driven machines—coal cutters, loaders, hoists, etc. Portable substations are built in three units and mounted on mine car wheels or on skids. Over-all height of 42 inches is available. They afford fully automatic operation, low maintenance costs, high efficiency at all loads, and will remain undamaged by extreme overloads.



A typical 3-truck Ignitron substation complete with dry type ASL Transformer, sealed Ignitron, automatic a-c and d-c switchgear

COMPLETE ELECTRICAL EQUIPMENT FOR THE MINING INDUSTRIES

driving motors

Westinghouse offers a complete line of motors in various speeds and horsepowers suitable for all mine drive service. In addition to open motors, explosion-tested and splash-proof types are available.

A-C Motors—Fractional or integral hp single, polyphase or universal, and squirrel cage induction, wound rotor or synchronous types can be supplied in standard voltages, frequencies and ratings from ½ to 200 hp to meet all requirements.

D-C Motors—Available in fractional or integral hp types with shunt, series or compound windings; also universal types can be supplied. Ratings from ½ to 200 hp for operation on all standard voltages.

enclosures

Types for a-c and d-c integral hp motors listed above include:

Open—For general purpose applications where operating conditions require no special protection.

Totally Enclosed—(non-ventilated or fan-cooled)—recommended where abrasive or metallic dust is present or where excessive quantities of dust of any kind are present. Explosion-Proof (totally enclosed or fan-cooled), recommended where the atmosphere may contain combustible or explosive dust or vapor in dangerous quantities. Motors built to comply with requirements of Underwriters Laboratories for Class I, Group D and for Class II, Groups E, F and G to comply with U. S. Bureau of Mines requirements for motors in hazardous locations underground.

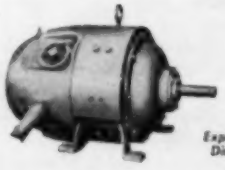
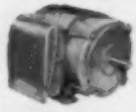
Splash-Proof—for use where motors are frequently cleaned by hosing down. Construction prevents drops of liquid or solid particles from entering the machine.

gearmotors and speed reducers

Westinghouse manufactures a complete line of parallel shaft type single or double reduction gearmotors and speed reducers for every requirement. Manufactured in accordance with the recommended practice of the American Gear Manufacturers' Association. For full details ask for Descriptive Bulletin 3600 (Gearmotors) or 6650 (Speed Reducers).

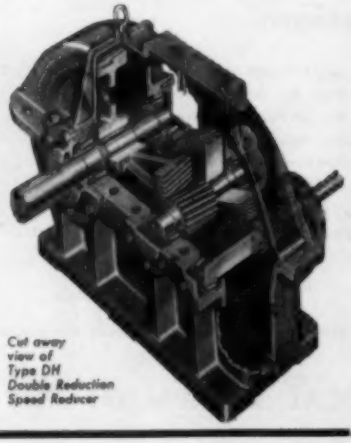
Gearmotors are self-contained drives, each consisting of a high speed Westinghouse motor and speed reducing unit. Available in all standard ratings of 1 to 75 hp, units can be furnished with practically any standard type Westinghouse a-c or d-c motor to meet individual requirements.

Speed reducers economically transmit power from high-speed motors or engines to exact speed requirements for driven machines. These units are the external geared type with shafts arranged in a horizontal plane.

integral hp motors	direct-current		single-phase	
	 Explosion Tested Direct Current Type SK		 Type ALDP	
Motor Design	Shunt, Ser. or Comp. Wound	Series or Comp. Wound	Capacitor	
TYPE	SK	CKT	ALDP	CAP
Starting Method	Across-the-Line or Reduced Voltage		Capacitor	
Starting Torque	High	High	Normal and High	
Hp Range—Motor	½ to 200	5 to 100	¾ to 10	
Speed Characteristics	Constant-Varying	Varying	Constant	
Approx. Full Load Rpm — 60 Cycle	1750	1350	3450 1755 1160	
Approx. Full Load Rpm — 50 Cycle	1150 850 690 575	1000 875 750 550	2880 1450 965	
Approx. Full Load Rpm — 25 Cycle			1450	
Standard Voltages	115 to 600	230	115/230	
Temperature Rise (Continuous Duty—Open)	40° C.	55° C. Intermittent	40° C.	
Type of Bearings	Sleeve, Ball or Roller	Sleeve or Roller	Ball	
Method of Reversing	Change Leads—Use Suitable Control			

1—Crane & Hoist

speed reducers



Cut away view of Type DH Double Reduction Speed Reducer

Westinghouse Speed Reducers are of the external geared type with shafts arranged in the horizontal plane. Available in two types: Single Reduction (SH)-ratios-1.84 to 9.21, Double Reduction (DH)-ratios-11.3 to 70.0. Special features include:

Simple Helical Gears—Teeth cut by the hobbing process for utmost accuracy. Exclusive Westinghouse BPT heat treatment given pinions and also to gears where necessary.

Simple Positive Lubrication—Efficient splash system assures thorough lubrication of gears and bearings. Labyrinth seal in end caps prevents oil leakage around shaft.

Anti-Friction Bearings—Tapered roller bearings are used throughout. They assure permanent shaft alignment—minimum friction loss and long, trouble-free service life.

motors • gearmotors speed reducers

polyphase a-c

Life-Line A

Type CSP

Type CWP

Type GP

Squirrel-Cage Induction								Wound Rotor Induction		Synchronous
L-L A[2]	CSP[2]	L-L A[3]	CSP[3]	L-L A[4]	CSP[4]	L-L A[5]	CSP[5]	CWP	CIP[5]	GP
Across-the-Line or Reduced Voltage								Across-the-Line or Reduced Voltage		Across-the-Line or Reduced Voltage
Normal	Normal	High	High	High Torque High Slip	High Torque High Slip	High Torque High Slip	High Torque High Slip	High	High	Normal
½ to 40	1 to 200	3 to 30	3 to 150	½ to 30	½ to 125	½ to 30	1½ to 50	½ to 200	¾ to 200	20 to 200
Constant	Constant	Constant	Constant	Constant	Constant	Constant	Constant	Varying	Varying	Constant
3450, 1755, 1165, 860, 700	3450, 1755, 1165, 860, 700	1750, 1160, 870, 700	1750, 1160, 870, 700	Depends Upon % Slip	Depends Upon % Slip	1600, 1050, 800	1600 1050 800	1740, 1145, 860, 675	1740, 1140, 860, 680, 565	1800, 1200, 900, 720, 600,514
2880 1450 965	2880 1450 965	1450 965	1450 965	5% to 13% Slip Available	5% to 13% Slip Available	1340, 880, 670	1340 880 670	1450 965	1430, 950, 710, 575, 480	1500, 1000, 750, 720
1450 725 480	1450 725 480	725 480	725 480			1300, 880, 650, 670	1300, 880, 650, 670	1500 750 500	710 470	750 500
208 to 550	208 to 2300	208 to550	208 to 2300	220 to 550	220 to 550	208, 550	208 to 550	208 to 550 and 2300	208 to 550	208 to 2300
40° C.	40° C.	40° C.	40° C.	40° C.	40° C.	50° C. Intermittent	50° C. Intermittent	40° C.	50° C. Intermittent	40° C.
Ball	Sleeve or Ball	Ball	Sleeve or Ball	Ball	Sleeve or Ball	Ball	Sleeve or Ball	Ball	Ball	Sleeve or Ball

Change Leads—Use Suitable Control.

[2]—NEMA design B. [3]—NEMA design C. [4]—Punch Press. [5]—Crane & Hoist.

gearmotors

Type A Single Reduction Unit available in the following ratios:

Gear Ratios	A.G.M.A. Full Load Output Speeds (Motor rpm 1750)
2.24	780
2.73	640
3.37	520
4.17	420
5.00	350
6.25	280

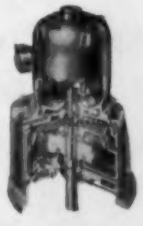
Type C Double Reduction Unit available in the following ratios:

Gear Ratios	A.G.M.A. Full Load Output Speeds (Motor rpm 1750)
7.61	230
9.21	190
11.3	155
14.0	125
17.5	100
20.8	84
25.7	68

Type E Double Reduction Unit available in the following ratios:

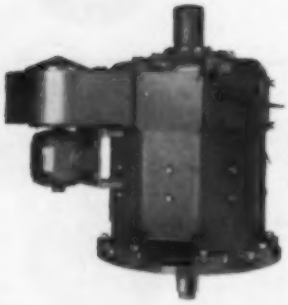
Gear Ratios	A.G.M.A. Full Load Output Speeds		
	Motor rpm		
	1750	1165	870
31.2	56	—	—
38.9	45	—	—
47.3	37	25	—
52.7	—	—	16.5
58.3	30	20	—

Type M Vertical Type, Double Reduction Unit available in the following ratios:



Gear Ratios	A.G.M.A. Full Load Output Speeds		
	Motor rpm		
	1750	1150	870
7.61	230	—	—
9.21	190	—	—
11.3	155	—	—
14.0	125	—	—
17.5	100	—	—
20.8	84	—	—
25.7	68	—	—
31.2	56	37	—
38.9	45	30	—
35.0	—	—	25

Westinghouse equipment for shovels and draglines



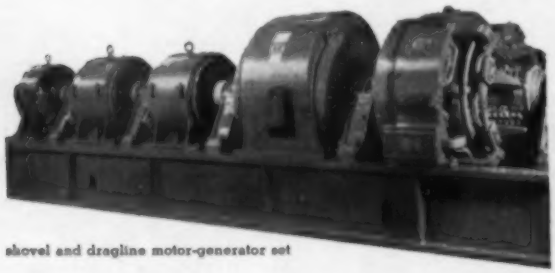
type MC vertical motor with forced draft ventilation

type MC motor

The type MC shovel motor is specially designed for hoist or drag service on smaller machines, and for crowd and swing on all types. Rated 7½ to 250 hp, it is rugged, compact, and gives fast starting, stopping, and reversing with safety. Small diameter armature has very low inertia. 230 and 550 volts d-c.

Horizontal motor—In this motor, used for the hoist, crowd, and drag, the motor frames are horizontally split. Top half swings up, exposing all operating parts, thus facilitating easy maintenance.

Vertical motor—Used for the swing operation, the frame is solid and can be removed by loosening the base bolts and lifting frame off.



shovel and dragline motor-generator set

motor-generator sets

Westinghouse M-G sets give you just the right amount of power for a highly efficient operation, with perfect co-ordination between generators and motors. Shovel and dragline motor generator sets are designed with the rating and operating characteristics matched to your specific drive.

Each armature is carried in two sealed ball bearings, making each unit complete by itself. Units of the set are flexibly coupled to allow for any shaft mis-alignment that may occur during operation. For small equipments Westinghouse has a dual-circuit generator for the swing and crowd motors.

Rototrol control unit

Rototrol®

Rototrol does a superb job of controlling motor speed and factors of torque, tension or acceleration regardless of varying load conditions.

Rototrol provides fast operating cycles with smooth acceleration and deceleration and limits mechanical stress in the shovel structure. Operator can work at top efficiency and doesn't have to worry about damaging equipment when applying full power.

The drive is extremely fast. Rototrol takes the small amount of current within working ranges of the master controller and quickly amplifies it to a point where it "forces" the generators to instantly deliver the required power to the d-c motors. The system consists of a master controller, the Rototrol itself and a minimum of resistors and field circuit contactors. Because of its simplicity the Rototrol system is very easy to service.

skid-mounted portable switchhouse, sideplates removed

portable switchhouses

Westinghouse portable switchhouses are used to carry the circuit protective equipment for individual shovel feeders. These units are skid mounted to facilitate easy movement as stripping progresses. This switchhouse handles three outgoing feeder cables. It contains an oil circuit breaker, disconnect switches, overload and ground protective equipment and plug-type receptacles.

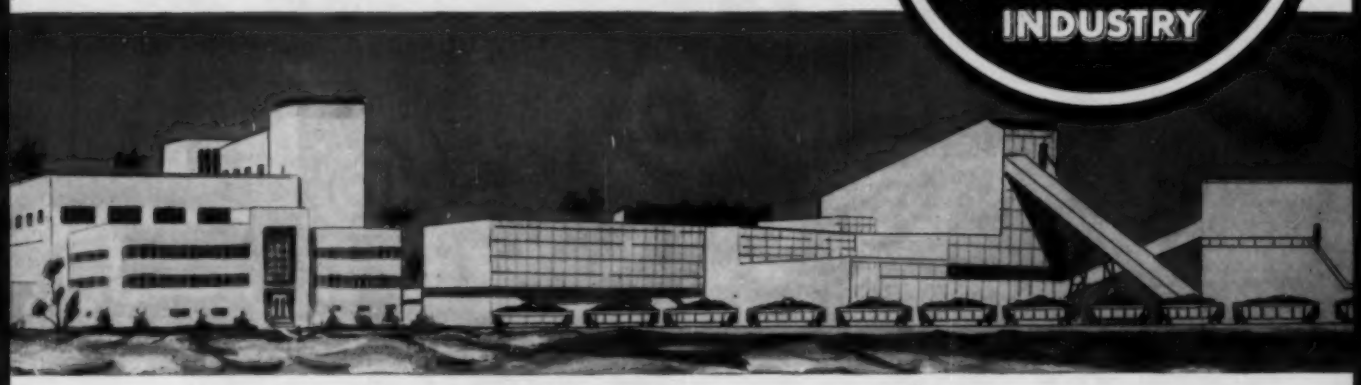
Westinghouse Electric Corporation • P. O. Box 868, Pittsburgh 30, Pa.

See directory section of Mining Guidebook for list of Westinghouse offices.

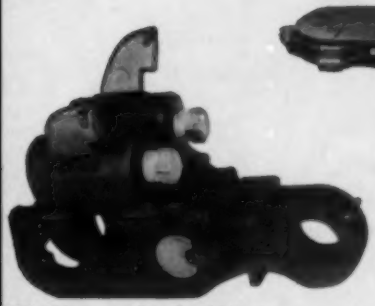
CINCINNATI MINE offers a complete line of Chains and Bits for every type of Mining Machine

CINCINNATI MINE offers the most complete line of CHAINS, BITS and BARS for CONVENTIONAL or CONTINUOUS MINING MACHINES for all cutting conditions. "CINCINNATI" is also recognized as the leader in research, design and practical application of this equipment. This leadership is based on more than 30 years of EXPERIENCE AND SPECIALIZATION . . . backed by highly trained personnel with a sincere desire to better serve the Industry.

PROUD OF OUR CONTRIBUTION TO THE PROGRESS OF A GREAT INDUSTRY



Cincinnati Cutter Bar Assembly Available For Any Cutting Job.



TYPE 185 . . . used on Joy Continuous Mining Machines where flanges are NOT required. Chain features a SERIES OF SELF CLEANING DEVICES.

STANDARD KERF TRIMMING CHAIN for use on boring type Continuous Miner. Sturdy, rivetless type construction.

CINCINNATI DUPLEX CHAIN AND BIT is recommended for maximum cutting efficiency and for use on all types of cutting machines.

DUPLEX F-TYPE TIPPED BIT. Where cutting conditions are favorable, it is undoubtedly the most economical tipped bit on the market.

REPRESENTATIVES AT YOUR SERVICE

FRANK ARMSTRONG
Kenilworth, Utah

CARLSBAD SUPPLY CO.
Carlsbad, New Mexico

GORMAN'S LIMITED
Drumheller, Alberta; Edmonton, Alberta, Canada.

W. M. HALES CO.
Chicago, Ill.; Danville, Ill.; Hillsboro, Ill.; Benton, Ill.; West Frankfort, Ill.; Madisonville, Ky.

HUNTINGTON SUPPLY & EQUIPMENT CO.
Huntington, W. Va.

F. G. LICENCE (PTY) LTD.
Durban, South Africa

McCOMB SUPPLY CO.
Harlan, Ky.; Jellico, Tenn.

PENN MACHINE CO.
Johnstown, Pa.; Pittsburgh, Pa.

SOCIEDAD IMPORTADORA DEL PACIFICO LTDA.
Santiago, Chile.

E. S. STEPHENSON & CO. LTD.
Halifax, N. S., Canada; St. John, N. B., Canada.

J. T. SUDDUTH & CO. INC.
Birmingham, Ala.

UNION SUPPLY CO.
Denver, Colo.

the **CINCINNATI MINE MACHINERY CO.**

CINCINNATI 25, OHIO

ENGINEERING
REPORTS:
Powered by General Electric system . . .
New 55-cu. yd. stripper
RIVER QUEEN

removes 5000 tons per hour

Huge Bucyrus-Erie shovel built for River Queen mine removes 90-foot overburden, has 55-second duty cycle

At River Queen mine in Western Kentucky, the largest power shovel ever built by Bucyrus-Erie Co. strips 90-foot overburden at a rate of more than 5000 tons per hour. Built for Peabody Coal Company and W. G. Duncan Coal Company, joint owners of the mine, the 55-cubic-yard "River Queen" makes possible the simultaneous recovery of two coal seams, separated by a five-foot rock parting.

For this immense project Peabody, which operates the mine, specified General Electric equipment for the shovel's electrical system. General Electric engineers worked together with Bucyrus-Erie and Peabody engineers to design and install the electrical system.

Highlights of the electrical system are nine rugged G-E direct-current motors to power hoist, swing and crowd motions; four 200-hp induction motors to power the propel motion; quick-response amplidyne*-amplistat** control system which permits one man operation; and a 3750-kva substation that is skid-mounted for mobility over rough mining terrain.

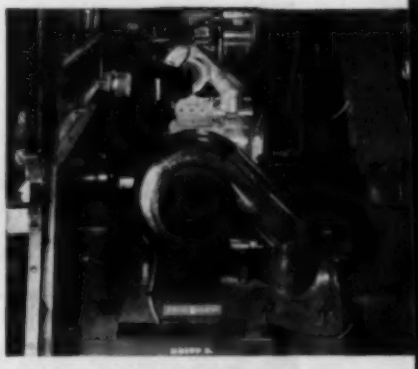
R. T. Taylor, Peabody electrical engineer, discussing the shovel's electrical system and performance, stated that Peabody has had excellent experience with G-E equipment in the past, and the equipment in the River Queen shovel has lived up to expectations.

In any phase of mining operation, G-E engineers and equipment can work for you. For information contact your local G-E Apparatus Sales Office or write General Electric Co., Section 663-47, Schenectady 5, N. Y.

*Amplidyne—rotating amplifier developed by General Electric Co.

**Amplistat—static amplifier developed by General Electric Co.

PROJECT PLANNERS include (l. to r.) R. M. McElwee, G-E sales engineer; R. T. Taylor, Peabody engineer; and J. E. Payne, Bucyrus-Erie field erection engineer.



HEAVY LOAD DEMANDS of hoist motion are met by four new General Electric MD-620 direct-current motors, rated 375-hp each.

Engineered Electrical Systems for the Mining Industry

GENERAL ELECTRIC

MAXIMUM direct-current output under heavy loads for River Queen shovel—up to 6000-hp—is provided by two General Electric synchronous motor-generator sets.

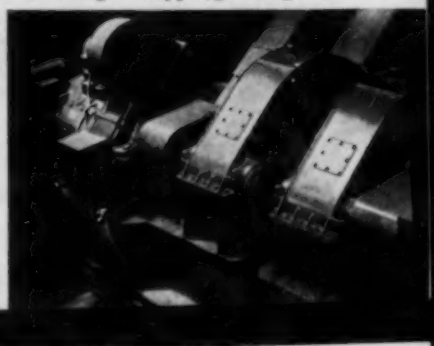
MOBILITY over rough mining terrain, obtained by a specially-constructed skid-mounted 3750-kva substation, places incoming power near shovel, minimizes voltage drop.

HEAVY DUTY swing motion is powered by three 187½-hp MD-616 General Electric direct-current armored motors, mounted vertically.

FAST RESPONSE and high-accuracy one-man control of River Queen shovel motors is provided by reliable General Electric amplidyne-amplistat electrical control system.

TRACTION POWER to propel massive, 2400-ton River Queen is supplied by four heavy-duty General Electric 200-hp wound-rotor induction motors (one shown).

HIGH TORQUE General Electric direct-current MD-616 motors, rated 187½-hp each, power crowd motion of giant dipper, give long life.



Bulk Materials Handling Systems

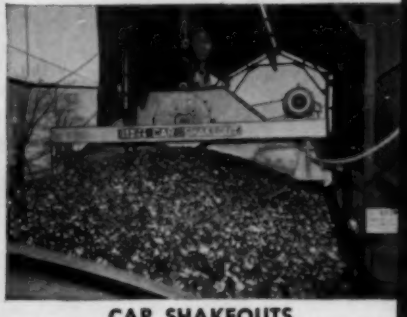
CONVEYOR BELTING

ELEVATOR BELTING

MONARCH FIRE HOSE

ENGINEERED CONVEYORS

TRIPPERS



CAR SHAKEOUTS

AIR HOSE

IDLERS

HEWITT-ROBINS MACHINERY PRODUCTS. A complete line of specialized machinery for conveying, screening, sizing, elevating, distributing, blending, and storing loose bulk materials of every description.

HEWITT-ROBINS RUBBER PRODUCTS. A wide range of rubber conveyor belts, transmission belts, industrial rubber hoses, and molded rubber products.

HEWITT-ROBINS ENGINEERING SERVICE. Our engineers' vast experience qualifies them to solve almost any bulk materials handling and processing problem which might arise.

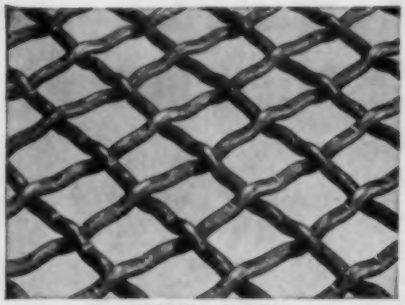
By dealing with Hewitt-Robins you'll save time and trouble . . . our products and services will furnish you with better integrated bulk materials handling systems and better designed and constructed processing equipment to solve your particular problem.

HR HEWITT-ROBINS

STAMFORD, CONNECTICUT

THE NAME THAT MEANS EVERYTHING IN BULK MATERIALS HANDLING SYSTEMS...

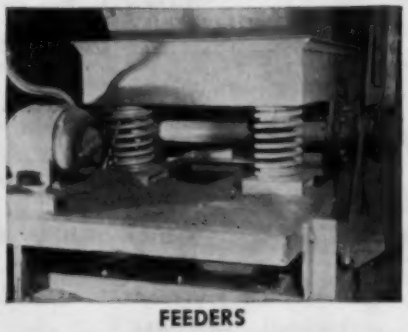
and Equipment for Industry



SCREEN CLOTH

STEAM HOSE

GYREX SCREENS



FEEDERS

ELIPTEX DEWATERIZER

PINCH VALVE HOSE

STACKERS

SECTIONAL CONVEYORS

Here is a partial list of HEWITT-ROBINS PRODUCTS that will help you cut handling costs and increase operating efficiency.

MACHINERY

Belt Conveyors
Belt & Bucket Elevators
Car Shakeouts
Conveyor Idlers
Dewaterizers
Mechanical Feeders
Mine Conveyors
Reclaiming Systems
Screen Cloth
Self-Unloading Boats
Ship Loading & Unloading Systems
Stackers & Trippers
Vibrating Conveyors & Screens
RoBINtronic® Bin Level Indicators

INDUSTRIAL RUBBER PRODUCTS

Belting:

Chute and Launder Lining
Conveyor
Elevator
Skirtboard Rubber
Transmission

Hose:

Acid
Air & Air Drill
Dredge Sleeves
Fire
Flexible Rubber Pipe
Fuel Oil & Gasoline
Gasoline Pump
Oil Suction & Discharge
Pinch Valve
Road Builders'
Sand Suction
Sea Loading
Servall®, All-Service
Steam
Vacuum & Air Brake
Water & Water Suction
Welding, Twin-Weld®

A-3202-X

INDUSTRIAL HOSE • VIBRATING CONVEYORS, SCREENS & SHAKEOUTS
CONVEYOR BELTING & IDLERS • POWER TRANSMISSION DRIVES

CUT BLAST HOLE COSTS

with **PORTADRILL** Model 6TA

LOWER INITIAL COST
FASTER PENETRATION
FASTER MOVING
LESS MANPOWER
LOWER COST OPERATIONS

Fully unitized, the 6TA is a tractor mounted rotary drill utilizing compressed air for cuttings removal. All power is furnished thru tractor engine. Completes 9" diameter holes to all blast hole depths.

DRILLS UP TO 3' PER MINUTE

Faster drilling cuts costs! Up to 27,000 pounds pressure on bits gives penetration speeds up to 3' per minute in average drilling including shales, limestones, sandstone and other hard formations.

PUT THE 6TA to work! Low initial cost, lower operational costs, faster moving that gives more drilling time, less manpower for efficient operations combine to give lower cost, faster blast hole operations.

COMPLETE DETAILS ON REQUEST

PORTADRILL
REG. U.S. PAT. OFF.

Ask for complete Specifications Bulletin 6TA-R

MANUFACTURED BY
WINTER-WEISS CO.
2201 Blake St., Denver 5, Colo., U.S.A.

Portadrill Models include conventional drills: "air blast" and combination air-water and Reverse circulation models—truck, tractor or trailer mounted for vertical hole operations to 2,000' depths and up to 60" diameters.

Have You Got Problems On

MAINTENANCE?

Why not check through pages 160-173 of this Guidebook for the latest developments in:

- Organization
- Reports
- Standardization
- Personnel Training
- Spare Equipment
- Lubrication
- Mobile Units
- Shops
- Scheduling

Who Makes What... And Where?

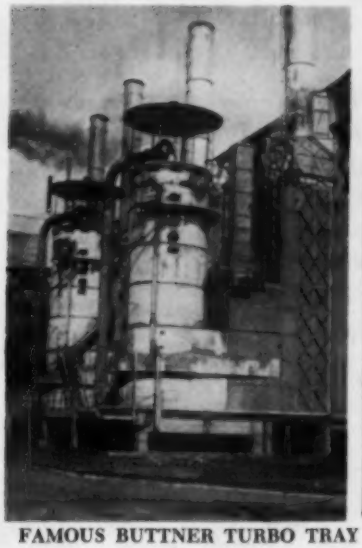
TO LOCATE MANUFACTURERS of equipment, materials and supplies used in maintenance, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

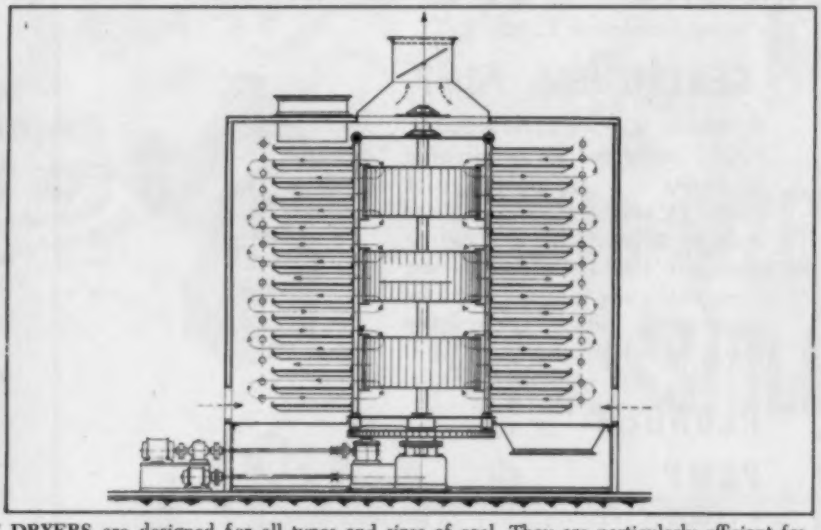
Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. Their district sales offices and distributors near you are listed in the Distributors' Index at the end of this issue. You'll find more useful information in their advertisements.

COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE

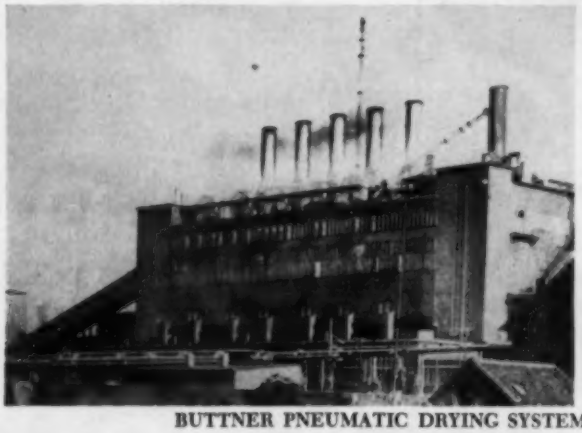
An established annual service for all COAL AGE subscribers

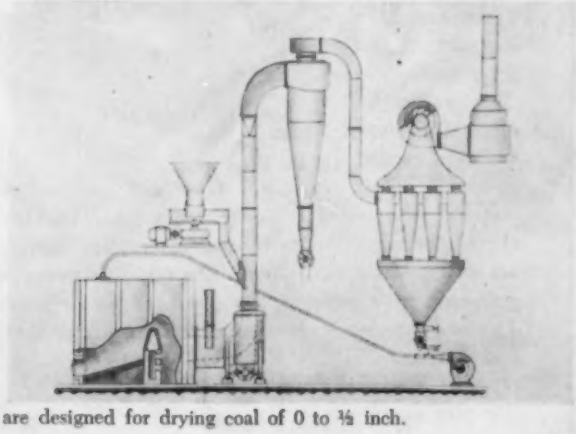
BUTTNER COAL DRYERS NOW AVAILABLE IN THE U. S.





FAMOUS BUTTNER TURBO TRAY DRYERS are designed for all types and sizes of coal. They are particularly efficient for complex drying and cooling problems.





BUTTNER PNEUMATIC DRYING SYSTEMS are designed for drying coal of 0 to ½ inch.

The Right Dryer for the Right Coal Product—Backed by 36 Years of Buttner's Experience in Coal Drying Problems

BUTTNER now offers two Standard Drying Systems in the United States that are designed to dry and cool efficiently all types of coal and related products. BUTTNER performance is backed by 80 years of industrial dryer engineering and manufacturing and 36 years of experience with coal plants—proved by installation of more than 100 coal dryers for all kinds of coal in 11 countries of the world.

BUTTNER coal dryers operate economically, are fully controlled and explosionproof. They feature economical installation, with low maintenance and operating costs. Some Buttner dryers have been in continuous operation for 25 years.

BUTTNER high-efficiency Dust Precipitation Equipment adds up to a dust-free operation.

Our engineering staff will gladly study your coal-drying problems and submit estimates, without obligation.

Write for Free Bulletin on Buttner Drying Systems

BUTTNER 75 SINCE 1874

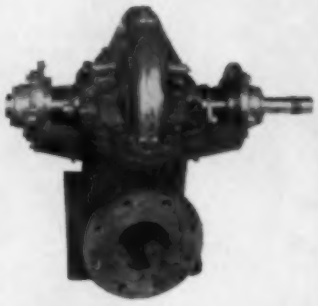
BUTTNER WORKS, INC.

52 Vanderbilt Ave., New York 17, N. Y. **Tel: MUrray Hill 9-5098**

PUMPS . . . *remember* FLOOD CITY

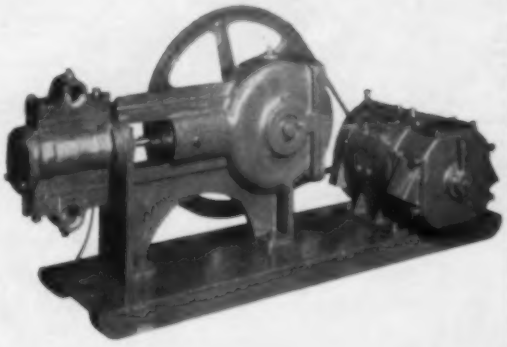
• For over 50 years we have been designing, building and repairing pumps of all types and sizes. Users recognize Flood City pumps for their efficient and trouble free service. When next you need a pump—remember FLOOD CITY.

CENTRIFUGAL PUMP



• FLOOD CITY CENTRIFUGAL PUMPS are dependable and designed by mining men for exacting mine service. Made in sizes up to and including 6" discharge with capacities up to 1500 gallons per minute. Pump bodies and operating units are furnished in either acid-resisting bronze or stainless steel.

PLUNGER PUMP



• FLOOD CITY gathering type PLUNGER PUMPS are light, compact, rugged and dependable. This pump has many uses above or below ground.

A double acting reversible water end can be specified in the material best suited for your application. The suction and discharge chambers can be quickly reversed so the pipe connections are in the position required. The self lubricating power frame is protected from wear at the crosshead fit by a cast iron sleeve. This power frame is shielded to prevent any entrance of damaging liquid or dirt.

We also manufacture a complete 5" x 5" plunger pump where more capacity is needed.

FLOOD CITY AUTOMATIC SYSTEM for operating CENTRIFUGAL PUMPS COSTS ONLY ABOUT ¼ THAT OF A VACUUM SYSTEM

Here's the new and inexpensive way to automatically operate your centrifugal pumps. Easy to install, and requiring only occasional inspection and maintenance, this system eliminates costly vacuum pumps.

Let a Flood City engineer supply you with all the details . . . there's no obligation . . . simply write or call.

SERVICE FC FIRST

FLOOD CITY
BRASS & ELECTRIC CO.
JOHNSTOWN, PA.

Sales Agent:
KANAWHA RAIL & MACHINERY CO.,
CHARLESTON, W. VA.

Want to Know What's Going on in
STRIP MINING?

Be sure to check through pages 102-133 of this Guidebook for the latest developments in:

- Preparing for Operation
- Overburden Preparation
- Stripping
- Coal Loading
- Transportation
- Power
- Drainage

Who Makes What...And Where?

TO LOCATE MANUFACTURERS of equipment, materials and supplies used in strip mining, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

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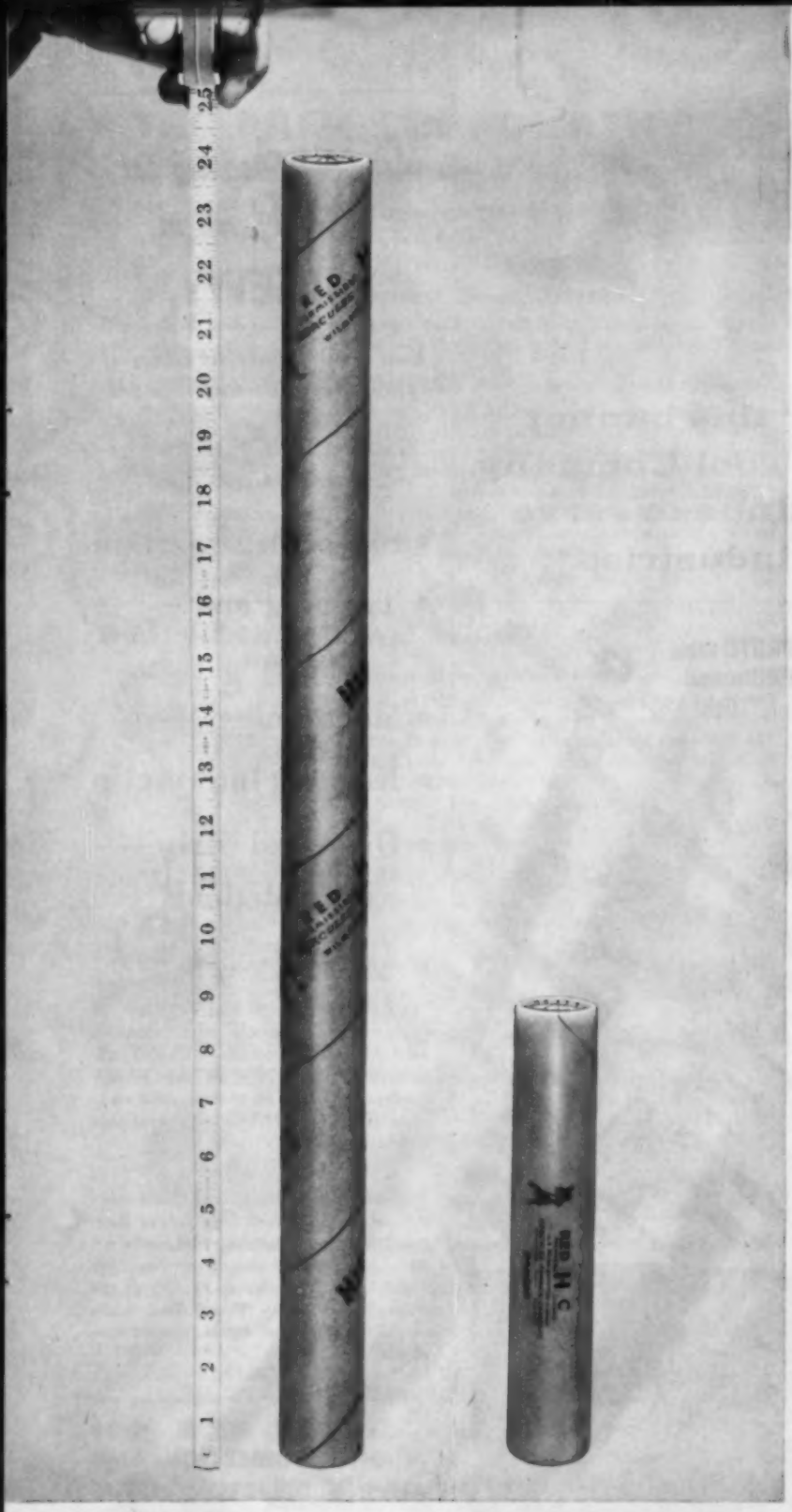
COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE

An established annual service for all COAL AGE subscribers



THE LONG AND THE SHORT OF IT . . . Here is a new Hercules "King-Size" permissible cartridge—24 inches in length—shown alongside the same grade in the conventional 8-inch size.

NOW... "KING-SIZE" PERMISSIBLES

Hercules permissible powders packed in "King-Size" cartridges are now available for use in coal mines. Field tests of these new "King-Size" cartridges show that they have many advantages, some of which are:

- **A continuous column of permissible powder in bore holes minimizes misfires and reduces the hazard of unshot powder in the coal.**
- **Predetermined cartridge weights effect economies in the powder consumption.**
- **Uniformity in loading produces uniform breakage.**

Hercules "King-Size" cartridges are supplied in most permissible grades, in lengths from 12 to 24 inches and in diameters of 1¼ to 2 inches.

Our representatives are ready to discuss your explosives needs and to give more information on how the new "King-Size" cartridges can do more work for you at lower cost.

HERCULES POWDER COMPANY
INCORPORATED
Explosives Department, 936 King Street, Wilmington 99, Delaware

Birmingham, Ala.; Chicago, Ill.; Duluth, Minn.; Hazleton, Pa.; Joplin, Mo.; Los Angeles, Calif.; New York, N. Y.; Pittsburgh, Pa.; Salt Lake City, Utah; San Francisco, Calif.

XR55-8

HERCULES

Under this banner the Proto Tool Company will continue to serve the needs of all industries

Founded in 1907, PROTO is the World's largest producer today of high-quality hand service tools. Leadership is attributable mainly to the *professional* quality of PROTO tools—resulting from intensive research, field-tested designs, special alloy steels, and superior manufacturing.

PROTO means PROfessional TOols!

PROTO TOOLS
PROTO means PROfessional TOols
DIVISION OF

2209 SANTA FE AVE.
LOS ANGELES, CALIF.

583 ALLEN STREET
JAMESTOWN, NEW YORK

Are You Shooting for New Records in SAFETY?

You find plenty of ideas if you check through pages 186-193 of this Guidebook for the latest developments in:

- Safety Organization
- Training and Education
- Maintaining Mine
- Keeping Interest Up
- Deep and Strip Safety Methods

Who Makes What... And Where?

TO LOCATE MANUFACTURERS of equipment, materials and supplies used in safety, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

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COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE

An established annual service for all COAL AGE subscribers

THE FALK CORPORATION • MILWAUKEE 1, WISCONSIN

Manufacturers of a Complete Line of Quality Gear Drives and Flexible Shaft Couplings for Industry

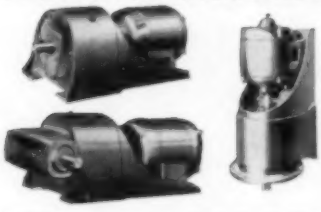
Representatives and Distributors in most principal cities

• •

Falk Standard Gear Drives

The helical and spiral bevel gears used in Falk gear drives assure highest attainable mechanical efficiency — 98½% per gear train under full load.

ALL-MOTOR MOTOREDUCERS *Package drives up to 75 hp capacity.*



A Falk All-Motor unit may be used with any standard foot-mounted motor within the rated capacity of the gear unit. Standard output speeds from 1.2 to 520 rpm (with 1750 rpm motors); ratios as high as 54,000:1 in semi-standard designs. All-steel construction. Integral units also available in the range from 1 to 40 hp.

Ask for Bulletin 3100.

SHAFT MOUNTED DRIVES *Up to 40 hp.*

Horizontal or Vertical Units

V-belt or chain connected to prime mover. Single and double reduction all-steel units in seven sizes provide choice of wide range of output speeds between 420 and 5 rpm. Maximum torque rating at low speed shaft: 31,000 lb-in.

Ask for Bulletin 7100.

SMALL SPEED REDUCERS *Up to 138 hp.*

◄ **Concentric Shaft** Ratios from 1.5:1 to 969:1. Max. torque rating at low speed shaft: 53,000 lb-in.

Right Angle ►

Ratios from 5:1 to 1459:1. Max. torque rating at low speed shaft: 73,000 lb-in.

Ask for Bulletin 1105.

LARGE SPEED REDUCERS *Up to 3500 hp.*

Parallel Shaft

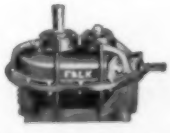
Up to 3500 hp. Ratio range: from 2:1 to 300:1. Max. catalog torque rating at low speed shaft: 1,950,000 lb-in.

Bulletin 1110B.

Right Angle Horizontal

Up to 1000 hp. Ratio range from 1.5:1 to 515:1. Max. catalog torque rating at low speed shaft: 569,000 lb-in.

Bulletin 2105A.



Right Angle Vertical

Up to 760 hp. Ratio range from 6:1 to 430:1. Max. catalog torque rating at low speed shaft: 714,000 lb-in. (Shafts up or down.)

Bulletin 2110B.

HIGH SPEED DRIVES *Reducers and increasers.*

◄ **Up to 225 hp.**
Maximum rpm — approx. 4500.
Bulletin 1106.

Up to 5000 hp. ►
Maximum rpm — approx. 9000.
Bulletin 5105.

Special GEAR DRIVES *for any application.*

Special HIGH SPEED DRIVES *. . . over 50,000 rpm.*

Marine PROPULSION DRIVES *turbine and diesel driven*

Falk Flexible Shaft Couplings protect the machines they connect.

STEELFLEX COUPLINGS

34 sizes covering a hp range from ½ through 72,000 hp at 100 rpm. Torsionally resilient grid-groove design cushions impact and starting loads as much as 30% and accommodates reasonable degrees of shaft misalignment which may occur between regular inspections.

Ask for Bulletin 4100.

BASIC TYPE F for 9 out of 10 applications, horizontal or vertical. Also dual-purpose designs for torque control, brake-wheel service, piloted shafts, etc.

AIRFLEX COUPLINGS

15 sizes covering a range from 5 through 2400 hp at 100 rpm. Ideal for applications which have irregular torque characteristics in driving or driven machines (internal combustion engines, compressors, etc.).

Ask for Bulletin 8100.

Designed for mounting shaft-to-shaft, shaft-to-flywheel, or shaft-to-flange.

FALK SINGLE HELICAL AND HERRINGBONE GEARS

Designed for any industrial application. Falk exclusive full-depth tooth form provides greater load-carrying capacity. AGMA ratings.

• •

Diameters up to 18 ft.
Face Widths up to 6 ft.

Diametral Pitch — ¾ to 6 dp.

• •

Hub or ring gears in solid or split designs.

Ask for Engineering Reports 6170 & 6171.

Hub Gears

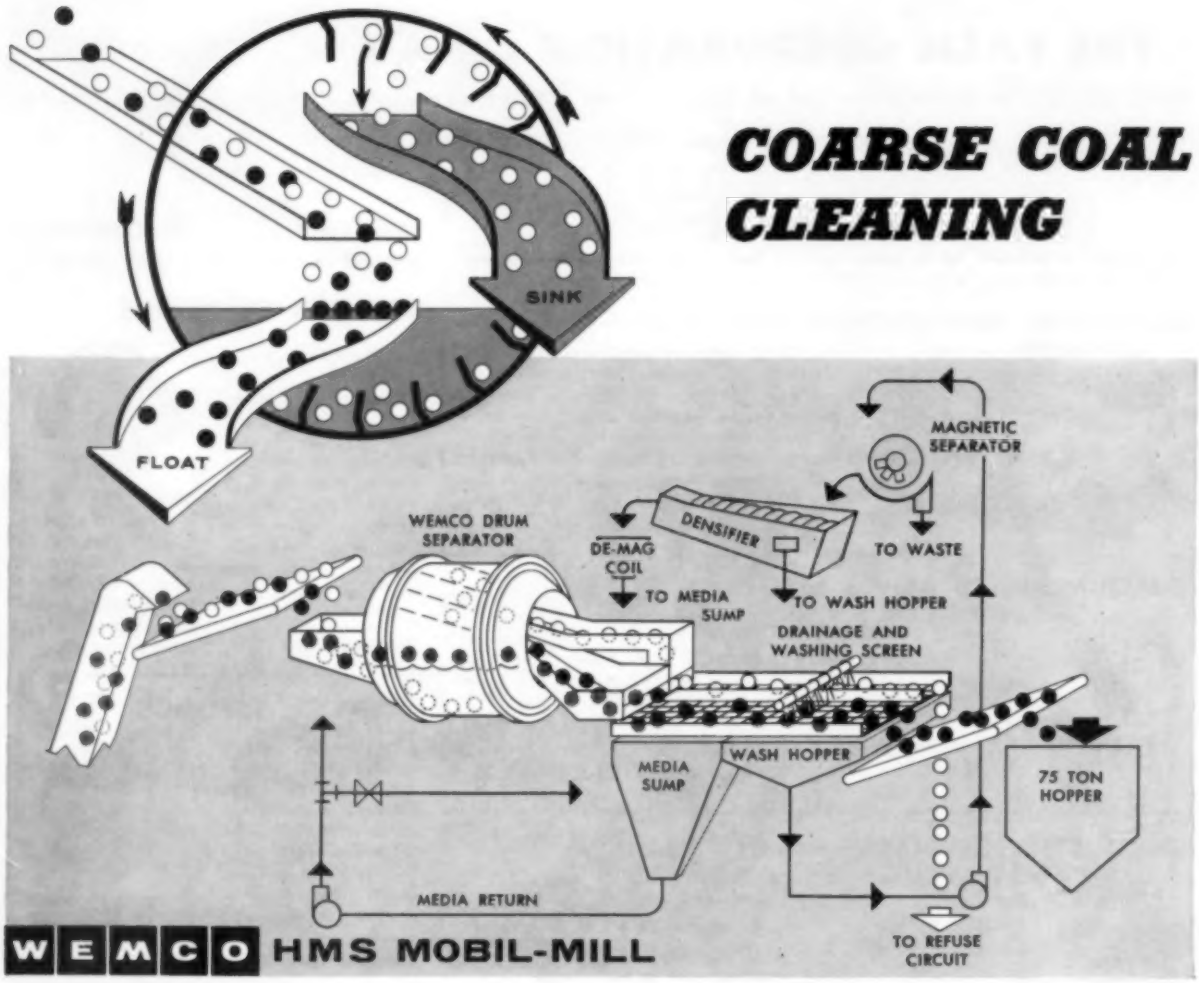
Ring Gears

Mill Pinions

FALK

. . . a good name in industry

COARSE COAL CLEANING



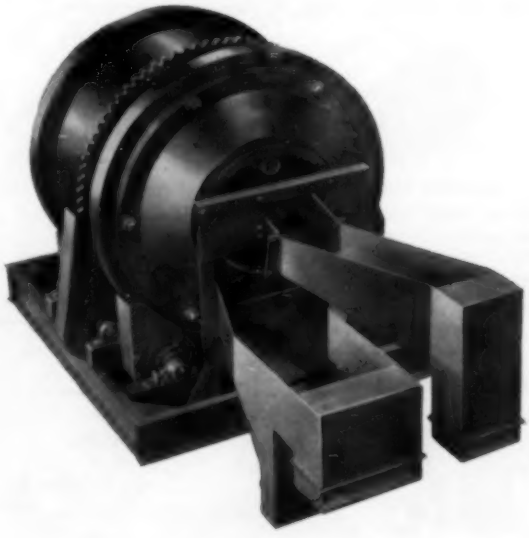
PERFORMANCE-PROVED IN HUNDREDS OF INSTALLATIONS

Wide application—wherever there is a gravity differential . . . size range 3/16" to 10" . . . capacity range to 500 TPH per unit.

Pre-Engineered—can be erected and operating within a few days after delivery at the site.

Cleanest separation—low ash content, high capacity production from single-drum. Two-compartment drum available to produce middling product for direct sale or for reprocessing. Cone separation also available.

For YOUR Application—simple lab or pilot testing will clearly indicate the proper flowsheet for maximum up-grading of your product. A WEMCO applications Engineer is available at your request.



WESTERN MACHINERY COMPANY • 650 FIFTH STREET • SAN FRANCISCO 7, CALIF.

NEW YORK • CHICAGO • LOS ANGELES • SALT LAKE CITY • SPOKANE • DENVER • GRAND JUNCTION • PHOENIX • HIBBING • TORONTO

WEMCO FLOTATION FOR FINE COAL CLEANING

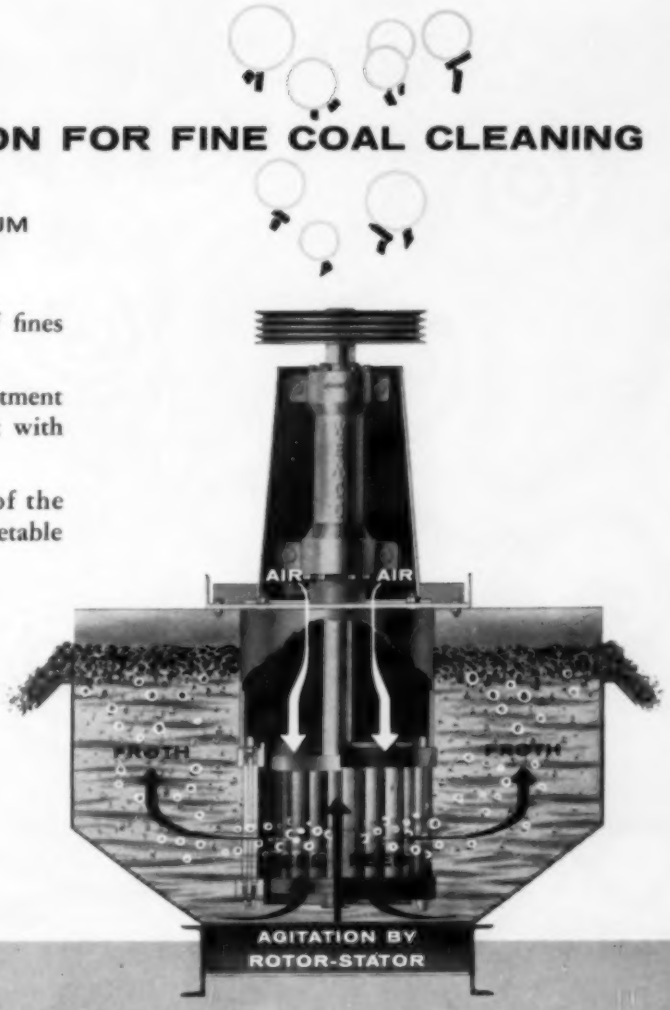
"COAL ENGINEERED" FOR MAXIMUM TONNAGE AT MINIMUM COST

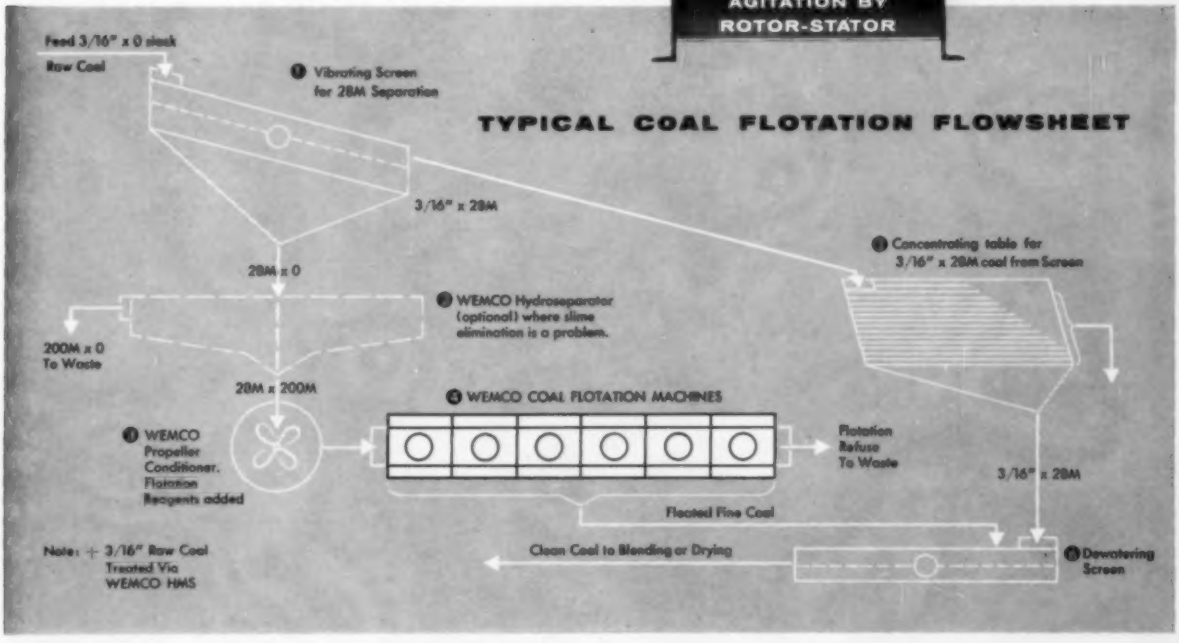
Size Range—cleaning and up-grading of fines from -28 mesh to 0.

High Efficiency—High capacity in the treatment of fine coal . . . produce saleable product with minimum ash content.

Greater Economy—superior aeration of the Wemco cell floats a larger tonnage of marketable fine coal.

Advance Proof of Performance—consultation with a Wemco Application Engineer is available at your request...learn how use of Wemco Flotation can result in greater profits to you. No matter what your coal cleaning problem, it will pay you to investigate Wemco designed circuits and equipment.




TYPICAL COAL FLOTATION FLOWSHEET
Feed 3/16" x 0 slack
Raw Coal
1 Vibrating Screen for 28M Separation
3/16" x 28M
28M x 0
2 WEMCO Hydroseparator (optional) where slime elimination is a problem.
200M x 0
To Waste
28M x 200M
3 WEMCO Propeller Conditioner. Flotation Reagents added
4 WEMCO COAL FLOTATION MACHINES
Flotation Refuse To Waste
5 Concentrating table for 3/16" x 28M coal from Screen
3/16" x 28M
Floated Fine Coal
Clean Coal to Blending or Drying
6 Dewatering Screen
Note: + 3/16" Raw Coal Treated Via WEMCO HMS

WESTERN MACHINERY COMPANY • 650 FIFTH STREET • SAN FRANCISCO 7, CALIF.

NEW YORK • CHICAGO • LOS ANGELES • SALT LAKE CITY • SPOKANE • DENVER • GRAND JUNCTION • PHOENIX • HIBBING • TORONTO

Leman "factory-authorized" repairs will put your equipment back to making profits in a hurry....

PROMPT REPAIR SERVICE PICK-UP RIGHT AT THE JOB OF DAMAGED OR WORN EQUIPMENT

Yes, even the heaviest mining machines and equipment are back on the job faster when Leman Machine Company does the repair work. A complete, modern machine plant and full staff of specialists enable Leman to assure you of prompt, efficient service that saves time and money.

The plant and equipment layout at Leman's is similar to the manufacturer's production line. There's no wasted motion to boost repair costs and you get workmanship equal to that of the original equipment producer.

LEADING IN MINING EQUIPMENT REPAIRS FOR OVER 35 YEARS

Authorized, recommended agency for repairing Jeffrey Equipment. Equipped to repair, rebuild or remodel all mobile loading and mining equipment and electric locomotives.

Long list of successful repair jobs includes Jeffrey, Joy, Goodman, Lee-Norse, Clarkson, Long, General Electric and Westinghouse mining equipment.

- Restore even heaviest equipment to original condition.
- Make modifications converting old machinery to latest models.
- Equipped to design new parts for specific requirements.
- Pickup and delivery right to jobsite reduces down time of equipment.

Phone or write for prompt, courteous service on your repair needs.

LEMAN
MACHINE COMPANY

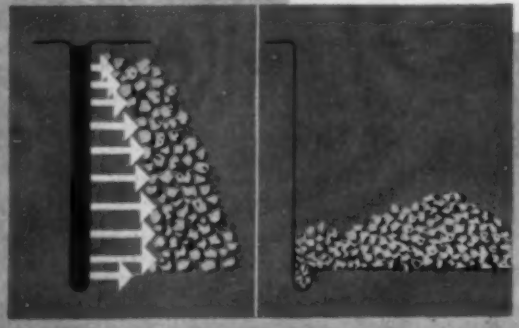
BOX 236 PORTAGE, PENNA. PHONE: PORTAGE 2051

HERE'S A NEWS BULLETIN

This technical bulletin contains information that can help you get quieter, more efficient blasts.

Every issue contains discussions on important blasting problems by D. M. McFarland, manager of the Technical Customer Service Section.

New, improved blasting procedures are graphically explained. New materials are reviewed and evaluated.



To keep users of explosives posted on the latest in blasting developments

You'll be up on new explosives products and blasting techniques that can give you more efficient, economical results when you become a regular reader of "*Better Blasting.*"

"*Better Blasting*" is published as a technical service by Atlas Powder Company. Each quarterly issue contains important safety information and such features as loading procedures that pay off in better shots . . . methods that minimize noise and vibration, and assure improved public relations.

You'll especially look forward to "Mac's Notes," an interesting column by Dave McFarland, often called "the father of millisecond delay blasting."

Start "*Better Blasting*" coming your way—free of cost or obligation. Write Atlas to put your name on the mailing list.

Ask also about the new Atlas safety movie, "*How to Handle Women and Explosives*" . . . or the public relations film, "*We're Blasting Near You,*" which you can show to your neighbors to illustrate your efforts to minimize disturbance.

EXPLOSIVES DIVISION

ATLAS POWDER COMPANY

WILMINGTON 99, DELAWARE

offices in principal cities

"For General Work in coal, rock or ore there is not a better machine on the market today!"

This is the honest appraisal of mining management experiencing the operation of Whaley "Automats"

At this moment two Whaley "Automats" on the day shift and one on the night shift produce approximately 900 tons of coal per day for one mining company. In addition, these machines also load out two to eight inches of draw slate, as well as two to 10 inches of middle parting. For fast projection and all-purpose economy and efficiency, the Whaley "Automat", track-mounted or crawler with hydraulic drive, is maintaining profitable operations for many mining companies. Chief advantages are its low initial cost, low maintenance, low cost per ton of material loaded plus its versatility for effective entry driving and loading out waste materials. Here is a mechanical performer that has earned the respect and admiration of every underground mining man, who, when the going gets tough, orders: "Put that Whaley 'Automat' over there and we'll get this stuff out of here!" Write us today for complete data and information.

IMPORTANT: For those mines now equipped with Whaley "Automats" . . . conversion to our new Hydraulic Drive is readily available. One leading mine has converted four of their "Automats".

MYERS-WHALEY COMPANY, Knoxville, Tennessee

This BUYERS' GUIDE Is Right-Up-to-the-Minute

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1957 edition.

Manufacturers advertising in this issue appear in bold-face type in the Buying Directory. Their district sales offices and distributors near you are listed in the Distributors' Index at the end of this issue. You'll find more helpful product information in their advertisements.

COAL AGE's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all COAL AGE subscribers.

Can You Improve Your Handling of SUPPLIES?

Now's the time to check through pages 174-185 of this Guidebook for the latest developments in:

- Inventory Control
- Systems
- Use Records
- Storage and Handling
- Supply Houses
- Supply Delivery
- Waste Prevention

Who Makes What... And Where?

TO LOCATE MANUFACTURERS of equipment, materials and supplies used in supply handling, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the Industry.

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COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE

An established annual service for all COAL AGE subscribers

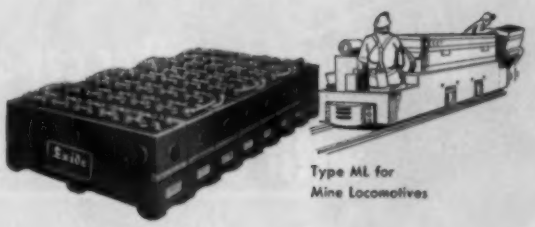
Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.

Exide®-IRONCLAD BATTERIES—

speed hauling, reduce costs

Want to cut your mine vehicle operating costs—boost productivity? Install Exide-Ironclad Batteries. These heavy-duty units give you that extra reserve of power that lets you make more trips per shift, get more production per man-hour, haul as much the last hour as the first. And because of their proven long life, even in the most severe service, they effectively reduce the cost of your battery power.

Make sure you are getting the maximum possible utility from your mine vehicles. Specify Exide-Ironclad Batteries. Available in a range of sizes to cover the requirements of every application.



Type ML for Mine Locomotives

EXCLUSIVE EXIDE-IRONCLAD ADVANTAGES:

Tubular construction of the positive plates is unique with Exide-Ironclad Batteries. Here's what this exclusive feature means to you:

⅓ greater effective plate area—power to spare for peak loads as well as a dependable source of power for continuous loads.

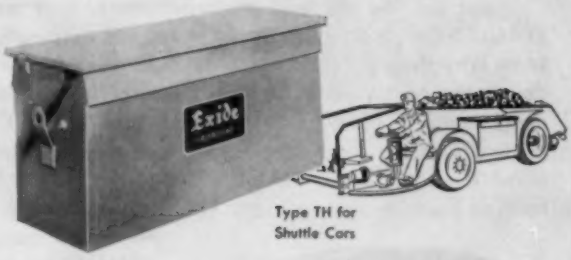
Longer plate life—active material is held firmly captive inside cylindrical power tubes, maintains electrical contact, can't shear off during cycling.

Pools of electrolyte next to plates—speed response to heavy load demands, insure maximum power from battery at all times, without delay.

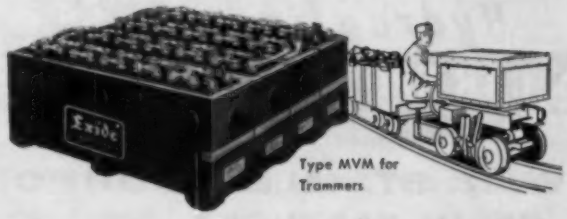
Silvium grids—exclusive patented Exide grid alloy resists corrosion, prolongs strength and thickness of grids, stretches battery life.

Vibration resistant—active material protected from shedding by cylindrical tubes, tiny openings let electrolyte in but keep active material from falling out; battery lasts longer in high vibration applications.

More active oxides—increase battery capacity, give Exide-Ironclad Batteries more power per pound; hence they have greater electrical efficiency.

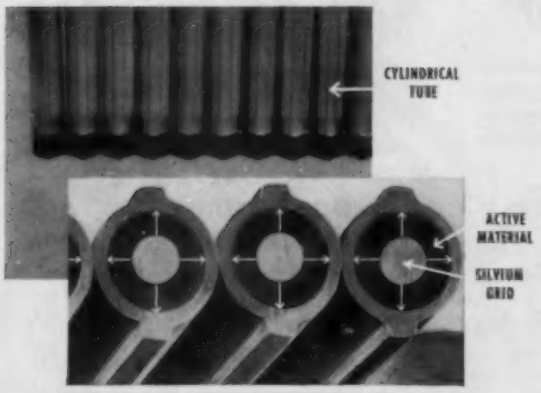


Type TH for Shuttle Cars



Type MVM for Trammers

Exclusive tubular construction of the Exide-Ironclad positive plate



For prices, specifications or free manual on maintaining motive power batteries, call or write the Exide sales office near you.

ATLANTA 10, GA.	1246 Allene Ave., S.W.
BOSTON 34, MASS.	100 Ashford Street
CHICAGO 9, ILL.	5335 S. Western Blvd.
CLEVELAND 14, OHIO	1014 Engineers Bldg.
DALLAS 1, TEX.	2133 McKinney Avenue
DETROIT 4, MICH.	8051 W. Chicago Blvd.
KANSAS CITY 23, MO.	129 S. Belmont Blvd.
LOS ANGELES 15, CALIF.	1043 S. Grand Avenue
MINNEAPOLIS 3, MINN.	1750 Hennepin Avenue
NEW ORLEANS 12, LA.	406 Civic Center Bldg.
NEW YORK 36, N.Y.	25 West 43rd Street
PHILADELPHIA 4, PA.	101 N. 33rd Street
PITTSBURGH 16, PA.	1608 Potomac Avenue
ST. LOUIS 8, MO.	3928 Lindell Blvd.
SAN FRANCISCO 24, CALIF.	6150 Third Street
SEATTLE 1, WASH.	500 Wall St.
WASHINGTON 6, D.C.	1819 "L" Street, N.W.

Ask the man WHO HAS USED BOTH!

HE WILL TELL YOU WHY he replaced his other car spotters with STAMLERS!

WE SAID it before and we say it again: DON'T BELIEVE US — *just ask the mining men who have had experience with STAMLER Car Spotters and with other car spotters.* Then you will know why they switched to STAMLERS. Then you will believe that during the past year STAMLERS have replaced other car spotters many times in many, many mines. And the shift to STAMLERS continues at an increasing pace! But there's really no mystery about it. It's just that STAMLER equipment out-performs all other loading point equipment; that STAMLER equipment increases tonnage and reduces costs; that STAMLER equipment operates at the lowest possible maintenance figure! *When are you going to join the swing to STAMLERS?*

STAMLER *Hydraulic* **CAR SPOTTERS**

SCHROEDER BROS., Exclusive Eastern Sales Agent
Pittsburgh, Pennsylvania
UNION INDUSTRIAL CORP., Carlsbad, New Mexico

W. R. STAMLER CORPORATION
PARIS, KENTUCKY

SALMON & CO., Birmingham, Alabama
WESTERN SALES ENGINEERING CO.,
Salt Lake City, Utah

Who Makes What . . Where Are They?

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COAL AGE's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all COAL AGE subscribers

Are You Keeping Up With New Methods in DEEP MINING?

Don't miss the newest ideas —check through pages 18-101 of this Guidebook for the latest developments in:

- Opening and Developing
- Mining and Loading
- Face Preparation
- Roof Control
- Transportation
- Ventilation
- Pumping and Drainage
- Electric Power

Who Makes What... And Where?

TO LOCATE MANUFACTURERS of equipment, materials and supplies used in deep mining, see the BUYING DIRECTORY SECTION of this Guidebook—the most up-to-date and complete BUYING DIRECTORY available in the industry.

Manufacturers advertising in this issue appear in bold-faced type in the Buying Directory. Their district sales offices and distributors near you are listed in the Distributors' Index at the end of this issue. You'll find more useful information in their advertisements.

When buying, or requesting product data, please mention

COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE

An established annual service for all COAL AGE subscribers

Duff-Norton Jacks

are safer, sturdier, faster, more economical—meet every modern mining need!

SINGLE ACTION RATCHET LOWERING JACKS WITH FOOT LIFT

514-MT
516-MT
521-MT

5 TONS Furnished with double round sockets and steel operating lever 1" x 30". *When jack is not under load,* head can be dropped or tripped instantly.

1017
1020
1022

10 TONS Furnished with either of the following sockets and operating levers: double round or small single round and steel lever 1¼" x 60"; large round and wooden lever 2⅛" x 48"; or square socket to fit your own lining bar.

1522
1528

15 TONS Double round socket and steel lever bar 1¼" x 60" long are standard equipment. Also furnished with large round socket and wood operating lever 2⅛" x 48" long; or square socket to fit your lining bars.

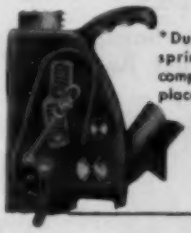
2028

20 TONS Double round sockets and steel lever 1¼" x 60". Also furnished with small single round socket; large round socket with wooden lever 3⅛" x 66"; or square socket to fit your lining bar.

Jacks can be furnished with either curved or flat tops.

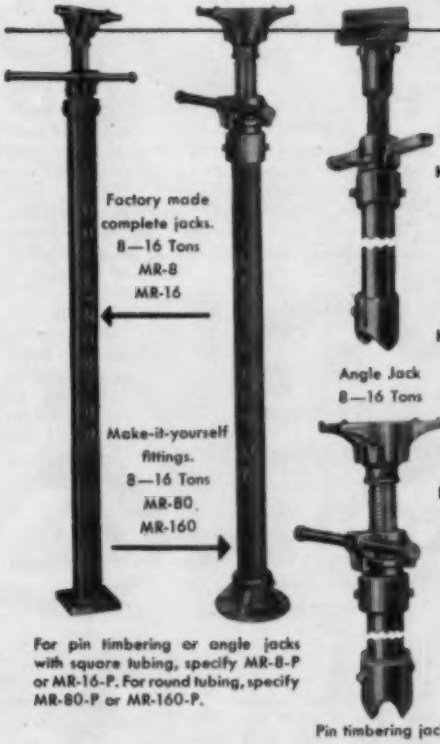
Every Duff-Norton ratchet jack is guaranteed at full capacity for loads applied to either head or foot lift.

Jack No.	514-MT	516-MT	521-MT	1017	1020	1022	1522	1528	2028
Cap. Tons	5	5	5	10	10	10	15	15	20
Ht. Ins.	14	16	21	17¼	20	22	22	28	28
Raise Ins.	7½	9½	14½	9	11½	12	11½	17½	18
Ft. Lift Ht. Ins.	1½	1½	1½	2¼	2¼	2¼	2½	2½	2½
Weight Lbs.	31	34	41	55	59	65	82	96	103



*Duff-Norton Patented spring mechanism, one complete unit—easily replaced.

MINE ROOF JACKS AND FITTING



Factory made complete jacks.
8—16 Tons
MR-8
MR-16

Angle Jack
8—16 Tons

Make-it-yourself fittings.
8—16 Tons
MR-80
MR-160

Pin timbering jacks
8—16 Tons

For pin timbering or angle jacks with square tubing, specify MR-8-P or MR-16-P. For round tubing, specify MR-80-P or MR-160-P.

JACK FITTINGS The following five heads, three handles, and three bases are available in any combination:

HEADS

TYPE "H"—used with 4" H-Beams or rails.

TYPE "B"—ball and socket for flat timbers, beams or direct contact.

TYPE "T"—6½", 8¼", and 11¼" sizes for H-beams, round or square timbers.

TYPE "L"—for angle support of ends of timbers, beams or rails.

TYPE "V"—for various diameter round timbers.

HANDLES

SLIDE HANDLE—for extra leverage in close quarters.

DROP HANDLE—similar to the slide handle except it folds down when not in use.

WING NUT HANDLE—for open areas where a firm, two-handed grip is possible.

BASES

ROUND BASE—cored pocket to fit on standard or extra strong pipe, with ⅛" diameter hole to fasten fitting to pipe. Use with ⅜" diameter bolt.

ROUND FISHTAIL BASE—cored pocket to fit standard or extra strong pipe, with ⅛" diameter hole to fasten fitting to pipe. Use ⅜" diameter bolt. End grooved to fit over 1½" diameter pin.

SQUARE FISHTAIL BASE—cored pocket to fit over end of square tubing, with ⅛" diameter hole to fasten fitting to pipe. Use with ⅜" diameter bolt. End is grooved to fit over 1½" diameter pin.

MR-8 or MR-8-P (Capacity 8 tons)
MR-16 or MR-16-P (Capacity 16 tons)

Minimum Height Closed	Maximum Height Open	MR-8 Weight Pounds	MR-16 Weight Pounds
30"	45"	31	45
36"	51"	33	48
42"	57"	34	51
48"	63"	36	54
54"	69"	38	56
60"	75"	40	59
66"	81"	42	62
72"	87"	43	65

PIPE NOT FURNISHED

Jack No.	Capacity Tons	Screw Dia Inches	Screw Raise Inches	Pipe Column to be used
MR-80 or MR-80-P	8	1½	15	2" Standard
MR-160 or MR-160-P	16	1¾	15	2" Extra Strength

Heights given are for type "B" heads. For other heads deduct 2" on MR-8 models, 1½" on MR-16 models. MR-8 screws are 1½" diameter. MR-16 screws 1¾" diameter.

Write for Bulletin AD10—

"A Handy Guide for Selecting Mine Jacks."

Duff-Norton Company

P. O. Box 1889 • Pittsburgh 30, Pennsylvania

Serving the Coal Industry Since 1923

WARNER LABORATORIES

ANALYSIS

SAMPLING • WASHABILITY TESTS

"ON THE SPOT"
COAL SAMPLING
IN PENNSYLVANIA
OHIO
WEST VIRGINIA

Adequate Samples
Insure Correct Analyses

These Representative Companies Have Used Our Facilities for Washability Tests.

Acosta Gray Company
Atlantic Crushed Coke Company
Cable Coal Company
Cambria Fuel Company
Clover Run Coal Company
Crichton Coal & Coke Company
Denise Coal Company
Dixonville Coal Company
Dunlo Coal Company
Dunwell Contractors
Ebensburg Coal Company
Elliot Coal Mining Company
Fetterolf Coal Company
W. O. Gulbranson
L. W. Hicks
C. A. Hughes & Company
Imperial Coal Corporation
Johnstown Coal & Coke Company
Marco Coal Company
Marshall Mining Company
Morrisdale Coal Mining Company
Nolan Engineers
Northwestern Mining & Exchange Company
Poole, Peacock & Karr, Incorporated
Pennsylvania Coal & Coke Corporation
Pennsylvania Electric Company
Penn Fuel & Supply Company
Pine Township Coal Company
Powell Coal Company
Reitz Coal Company
Rydesky Mines
Saxman Coal & Coke Company
Seanor Coal Company
Somerset Coal Corporation
Stineman Coal & Coke Company
Vinton Coal & Coke Company
Wieman & Ward Company
Westmoreland Mining Company
Wilmore Coal Company
Wilmore Fuel Company

• ***WE WILL*** *be glad to furnish estimates on tests to fit your coal on screen sizes from 5 inches to 200 mesh.*

WARNER LABORATORIES

Member American Council of Commercial Laboratories, Inc.

CRESSON, PA. **PHONE—CRESSON 2302**

For Your MINE TRACK Problems

Let us help you with our complete line of—

• Running Skids • Switch Signals • Rerailers

• Hinged Derails • Transition Rails

Write for our new bulletin.

MINERS' HARDWARE SUPPLY COMPANY

Republic Bldg., Pittsburgh 12, Pa.

"He'd Better Read COAL AGE," The Lady Said

"No, I don't try to tell George what he should be doing, and I certainly don't have to remind him to read COAL AGE every month. He's one of the most active COAL AGE boosters you've ever met," the charming wife of a successful young mining executive told us during a moment at the Coal Show.

"In his first job, George learned that COAL AGE was the easiest and best way of keeping up with the industry," she explained. "As he has progressed into better jobs, COAL AGE has gone right along with him. He depends on it to keep informed, to know what's new and significant, both in mining methods and news of the industry. No matter how busy he is, he makes it a point to go through the new issue as soon as it arrives.

"As a matter of fact, I'm a pretty enthusiastic COAL AGE reader myself," she confided. "I've been around the mines all my life and I enjoy looking at the pictures and learning what's going on."

Why not take a tip from George, if you're not seeing COAL AGE regularly or have to depend on an office-routed copy. Subscribe for your own copy today and see for yourself how COAL AGE can help you keep on top of new mining developments and important industry changes. (And if you have it sent to your home, perhaps your wife will enjoy it too.)

A year's trial subscription costs you only $3—a mighty small investment for the 1,000 editorial pages of industry news, mine descriptions, operating, technological and equipment data you'll get. Of course, we'll send COAL AGE wherever it's best for you, home or office. Just fill out the form below and send it along.

COAL AGE, Subscriber Service,
330 West 42nd St., New York 36, N. Y.
Send me COAL AGE for 1 year at $3 (U. S. and Canada only)

☐ Check enclosed ☐ Bill Company
☐ Bill me

Name .....
Mailing Address: ☐ Home ☐ Business
.....
.....
City ..... Zone ..... State .....
Mining Company .....
Your Position .....
Hdqs. or Mine Name .....

G257 To save delay, please fill out completely

The BOWDIL® co.

ORIGINATORS OF THROW-AWAY BITS; MANUFACTURERS OF BARS, BITS, CHAINS AND OTHER PRODUCTS FOR COAL MINING; CUSTOM MACHINERY DESIGNERS AND BUILDERS; HEAT-TREAT SPECIALISTS; SALES AGENTS FOR THE CINCINNATI ELECTRIC DRILL.

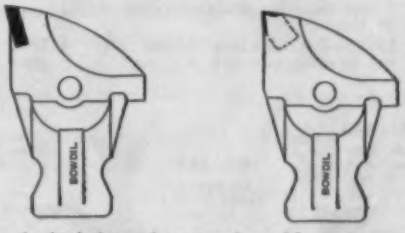
BOWDIL BITS

NEW I-29 CONCAVE

Patented concave design increases bit clearance, assures longer wear without increased power consumption. Made from special steel, rolled, with concave faces. Tests in hundreds of mines have proven these Bits last 15% to 20% longer. Bowdil makes the right size and shape bit for every mining condition, to fit all types of chain.

NEW CARBIDE TIP BITS

No. 1-27N3 No. 1-27N5



Superior in design and construction, with great strength and rigidity in the shank and clamping method.

BOWDIL CUTTER BARS

are designed for extra strength and power saving. Rivet-free body, Z bar construction, wide wearing strips make it the sturdiest bar in mining. Bowdil Bars are standardized to fit all mining machines.

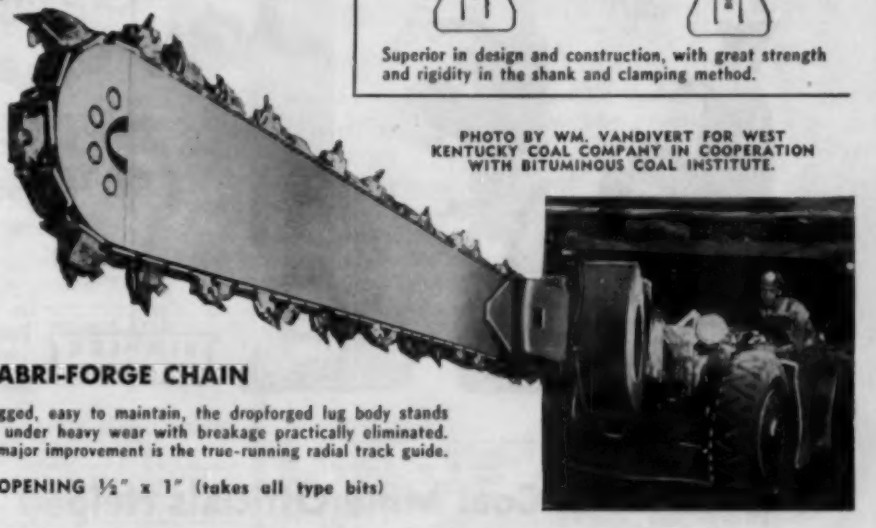


PHOTO BY WM. VANDIVERT FOR WEST KENTUCKY COAL COMPANY IN COOPERATION WITH BITUMINOUS COAL INSTITUTE.

FABRI-FORGE CHAIN

Rugged, easy to maintain, the dropforged lug body stands up under heavy wear with breakage practically eliminated. A major improvement is the true-running radial track guide.

NOW AVAILABLE WITH BIT OPENING ½" x 1" (takes all type bits)

NEW 6-IN-ROW RIPPER HEAD

Using 6 renewable independently adjusted Cutterbars, with all 6 Chains similar in kerf and lacing arrangement for interchangeability. All 6 spockets interchangeable. Improved design head drive shaft and sprocket assembly using 2 piece sprockets to maintain extreme tension to the shaft.

These are only a few of the features and advantages in this modern Ripper Head for Continuous Mining. Ask a Bowdil representative or write for more detailed information.

SPROCKETS FOR ALL MINING MACHINES

Bowdil Sprockets are made from special heat-treated alloy steel and designed for hard wear. Our stock of over 100 different styles includes clutch, spline and keyed types—various tooth designs of 4 to 13 teeth.

NEW TRIMMER CHAIN for all makes of CONTINUOUS BORING MACHINES

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- ★ Ratchet lowering lever type for speed with safety
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- ★ Double-lever sockets permit lifting in close quarters
- ★ Full capacity on cap *OR GROOVED* toe
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- ★ Ideal for re-railing, repairs, skidding

No. 84A for Thin Seams 14" high, 7" lift

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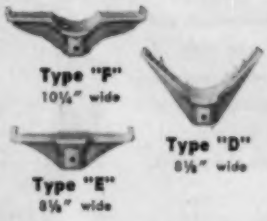
MODEL NO. 642
LIFTS 6 TONS

Combines safety of screw jack with fast action of crank. Head swivels. Five models with min. ht. from 3'6", max. ht. to 9'6".

3 TYPES OF HEADS



Type "F" 10¼" wide

Type "D" 8⅛" wide

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Write for Bulletin Mines 56 for data on the most complete line of Mine Jacks

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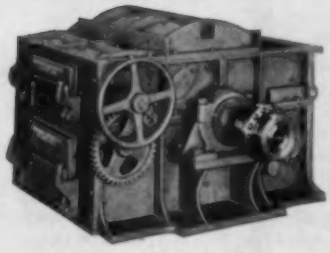

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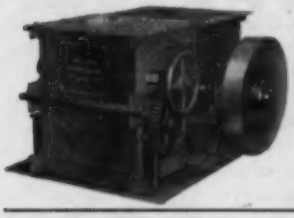
Capacities up to 800TPH. Extensively used for the reduction of ROM and lump coal to commercial screenings and stoker sizes. Operates at slow power saving speed, gives positive size control with a minimum of fines. Size of end product can be varied by external adjustments of grinding plate and drop cage.

Only American Crushers have the patented Rolling Shredder Rings which split coal instead of crushing it, thereby producing less fines.

Rings are made of manganese steel and are reversible to give double wear.



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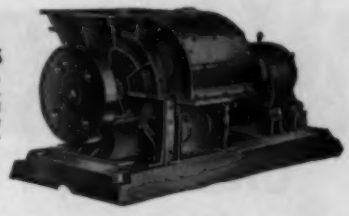
Made in 9 sizes with capacities up to 188 TPH. Very compact —makes ideal installation at mines or in yards underneath coal bin. External adjustments of Grinding Plate and Adjustable Drop Cage permits tailor made sizes to the truckload.

AMERICAN "S" TYPE CRUSHERS

Made in 8 sizes with capacities up to 500TPH for the reduction of ROM and lump coal to Screenings. Also used for crushing Middlings and Picking table refuse.



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Made in 4 sizes, with capacity up to 500 TPH. This Heavy Duty "S" Type Crusher reduces ROM Coal, gob, rock, slate, sulphur balls, etc. without oversize and eliminates the need for pickers. Pays for itself in short time in savings of labor and recovery of coal imbedded in impurities.

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Made in two sizes with capacities up to 2000 lbs. per hour. Sampling hopper gives a 5%—10%—15%—20% Sample of The Sample—For larger capacities we recommend the American "WC" or "13" Series with capacities up to 12 TPH.

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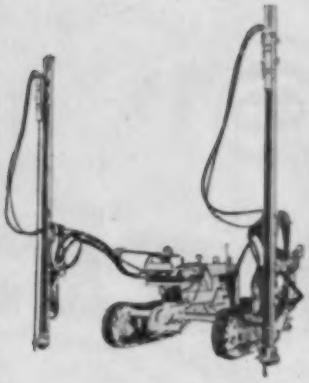

T-286 dual drill rig. Useful 25 hp tractor mounting two heavy-duty air-motor powered drill booms. Goes anywhere under its own power.

A complete line of sinkers from 17 to 80 lbs., featuring the new shock-absorbing design that has 55% less kick than other drills, but the same bit impact.

One-use detachable non-threaded bits for sinkers, drifters, and stopers. Special offset-gauge feature reduces binding and provides extra clearance for cutting so that drilling speeds are faster. Simple taper fit.

New Air-Leg design — way out in front of all others. Can be used as a stoper, drifter, or sinker. 3', 4', 5', and 6' feed legs — conventional or telescopic. Fine control, easily handled.

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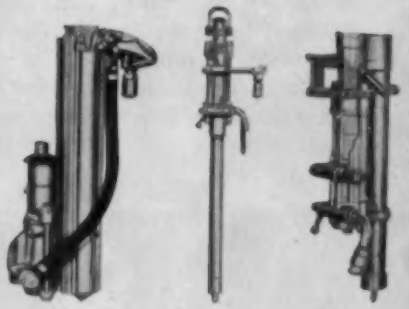
— a complete line of equipment for all types of mining!

Le Roi rock-drills are *designed* for mining — built to endure tough service and stay underground on the job. The Le Roi line includes a size and type of tool for every mining operation, including many not illustrated, such as mine jumbos, power-feed drifters, and others.

Operators like them because they are easy to run — owners love 'em because they stay at the face, not in the shop.

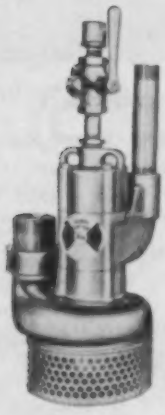
This all adds up to more feet of hole drilled per shift, increased man-shift production, and lower costs.

Try Le Roi rock drills — there's one just right for *your* job! For additional information, write us. We'll gladly send specifications and data.



Stopers for every need, featuring Vac-Nu-Matic dust collection and the Sav-A-Change chuck. Improved design means easier drilling. Conventional or telescopic feeds.

Heavy-duty DR40 feed shells with D14R drifter for deep drilling in extra hard ground.



Easy-handling, no-prime, air-operated sump pump for fast, efficient water removal, easy transportability. Capacities to 340 gpm, heads to 70 ft.

Le Roi shaft sinking Jumbo. 4 or 6 drills, all air-motor powered. Sinks shafts up to 28 ft. in diameter. For *fast* shaft-sinking.

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Reduce upkeep and replacements costs**

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Light in weight, strong in performance, Ruberoid corrugated asbestos sheets are fire-proof, weather-proof, non-corrosive. Ideal for installations exposed to acid, fumes, smoke or steam. Ruberoid corrugated sheets never need paint and are attractive and practical for both interior partitions and exterior siding.

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P. H. Aliff, owner of these coal-hauling Mack LRSW's, says, "These big dumpers are really producing for me around the clock—hauling twice as much as my old units." Like other operators, Mr. Aliff has discovered that . . .

Big trucks bring big savings in hauling costs

A contract hauler for The Red Parrot Coal Company in Prenter, West Virginia, Mr. Aliff was using small, gasoline-powered dump trucks. With these trucks, he experienced the expensive maintenance, fuel, and down-time costs that are normal with undersized equipment.

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For automatic bin level indication or control of bulk materials. Particularly suited to applications on bins subject to pressure or vacuum.
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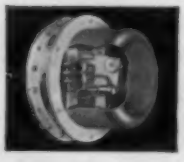

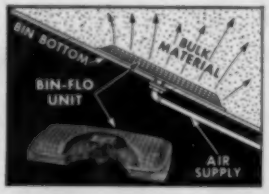

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ENTERPRISE CARS are built to meet *every* mine specification

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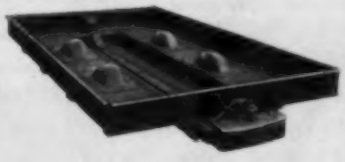

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Your insurance against haulage delays and shut-downs . . .
. . . MINE CARS

An experienced mine car engineering and production organization, backed by 58 years' experience, is at your disposal. Write us your haulage requirements and problems.

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Travelling unloading towers built to handle imported iron ore at an Atlantic port.

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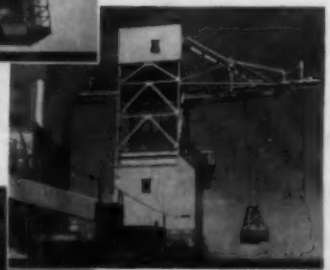
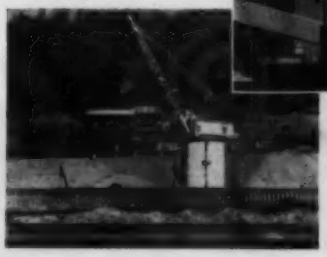


Coal unloader designed and built for a large mid-western electric power company.



Stationary whirler crane designed and built to transfer coal from barges to hopper cars.

Over-all economical and safe performance is best obtained by using materials-handling equipment designed to suit your operating conditions. If you're planning a new materials-handling installation, we suggest an early "Round Table" session with Dravo engineers.

From actual experience over the past 60 years in building and installing the equipment shown here, valuable data is available in working out the features you want in your installation. This information, along with your own operating experience, can be used to create a design incorporating all the best features for easy maintenance, a high safety factor and simple, economical and satisfactory operation.

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GRAYBAR offers a complete line of wire and cable for power distribution, for mining machinery and locomotives, shot firing, signaling, and other specialized needs.

Simplex mining machine cable has tough outer selenium-neoprene armor to stand up in mining service.

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General Electric motors and controls, meeting Bureau of Mines or Underwriters Laboratories requirements for hazardous areas, are available via GRAYBAR as a part of our power apparatus service. Ilg ventilating fans and blowers of all types are also available for mine use.

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EIMCO AGIDISC FILTERS dewatering fine coal. NOTE — smooth, evenly distributed cake formation.

WORLD'S BEST COAL FILTER

A new "Hy-Flow" design that improves operating efficiency in disc type filters combined with the Agidisc function of maintaining constant particle suspension makes the Eimco "Hy-Flow" Agidisc Filter, shown above, industry's most versatile coal fine dewaterer.

Enlarged ports, streamlined passages and direct flow are features of the "Hy-Flow" design. This allows unrestricted passage of liquids and gases from the filter media through the valve.

Vacuum loss is minimized since turbulence and right angle resistance bends are reduced. The "Hy-Flow" Agidisc includes newly designed valves, disc sectors, sector bells and trunnion barrels.

Comparison records of these filters in operation on the same feed as other filters substantiate advantages of the "Hy-Flow" design. Coal fines can be dewatered to a lower moisture content at less cost than with any other filter.

Standard Eimco Disc Filters are operating very satisfactorily in many of the Nation's top coal washing plants. The premium "Hy-Flow" design is recommended for plants where specifications require greater efficiency and clearer filtrates — where no additional treatment is needed before transfer of washwater to receiving waters.

It will be financially sound for you to review your filtering operation with an eye toward the Eimco "Hy-Flow" design. Or better still — send details to the Eimco Filtration Division. Let them apply their research and field knowledge to help you determine the proper route to better filtration and greater profits.

THE EIMCO CORPORATION

Salt Lake City, Utah—U.S.A. • Export Offices: Eimco Bldg., 52 South St., New York City

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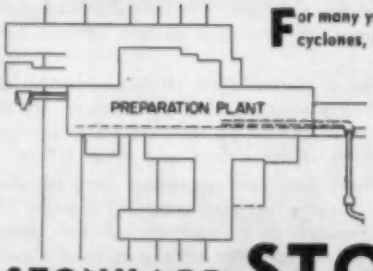
11-216

A copy of this quick-reading, 8-page booklet is yours for the asking. It contains many facts on the benefits derived from your business paper and tips on how to read more profitably. Write for the "WHY and HOW booklet."

McGraw-Hill Publishing Company, Room 2710, 330 West 42nd St., New York 36, N. Y.

NEW LINER SAVES OLD COAL CHUTES



For many years the problem of replacing chutes, cones, cyclones, hoppers, etc. has been a thorn in the side of the preparation plant superintendent. He knows the disastrous "chain reaction effects" of a breakdown in any of this vital equipment.

It is here that . . .

STONHARD STONCHUTE

Can Save Time, Trouble and Expense!

Steel alone can not satisfactorily withstand the eroding and corroding effects of coal handling. *A liner of STONCHUTE can greatly lengthen operating life of your equipment!* Send for full information on New, Sensational STONCHUTE.

STONHARD COMPANY, INC. 1306 Spring Garden St., Phila. 23, Pa.

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with the confidence justified by the offerings of these special services nationally.

MARTINDALE ELECTRIC CO.

1333 HIRD AVENUE • CLEVELAND 7, OHIO

MICA UNDERCUTTERS

— 9 MODELS —
6 Portable
3 Stationary
Electric or Air-Motor Driven

"Mica-Miller (illustrated) is a powerful Lightweight, low-cost, easy to use Undercutter, operating from 1/5 H.P. Universal motor. Available with small, medium or heavy-duty head (interchangeable).

MICA SAWS AND CUTTERS

We manufacture a complete line of all sizes of high-speed steel undercutter saws and "V"-cutters. Large stock of standard and special sizes carried at all times for immediate shipment.

COMMSTONES

5 grades for resurfacing commutators. 3 grades for iron and steel slip-rings. Sizes and handle styles for all needs.

COMMUTATOR GRINDERS

New and improved grinders for truing commutators and slip-rings make the job more accurate, faster and easier. Models to handle commutators up to 50 in. long without dismantling the machine.

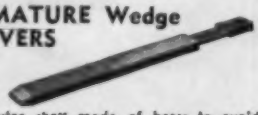
COMMSTONE HOLDER

Holds Commstones rigid and true for concentric resurfacing of commutators and slip-rings while running at normal speeds. Grinds commutators up to 4¾" wide. Used with two Commstones in stone holder or one Commstone in 2" box.

ARMATURE Wedge Remover

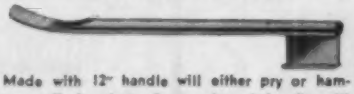
The coarse teeth on this tool bite firmly into wood and fiber wedges and save time in removing them quickly. Price $3.75

ARMATURE Wedge DRIVERS



Has outer shell made of brass to avoid rust. Driving pin made from steel. 11 sizes.

HANDLE TYPE COIL TAMPERS



Made with 12" handle will either pry or hammer coils in place. Spoon shaped handle will press ends of coil in position.

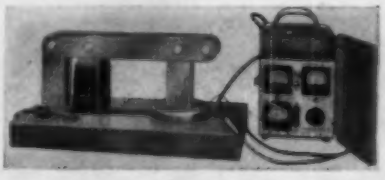
GROWLERS

Five types. Bench Type (B-1) illustrated. Portable types can be used both as external growlers for armatures, internal growlers for stators.

BEARING TOOLS

No. 1 Set above is used to insert or extract sleeve bearings from motors or other machines—Capacity ⅛" to 1-1/16". Set includes two bearing supports for different motor frames, 10 different taps, and Fan Motor Attachment for bearings less than ½".
We also have a No. 2 Set for larger bearings.

COIL TESTER MODEL 55



Detects shorts and opens. Shows number of turns in a coil from 10 to over 3000 turns. Specifications and prices in Catalog No. 31

WHEEL AND GEAR PULLER

Adjustable arms pull straight without squeezing the work. Set screws prevent spreading. Made in 2 styles and 4 sizes up to 24" diam.

MOTOR-FLEX UNITS

(flexible-shaft grinders) Martindale Motor - Flex-Units are made in 7 Models — 24 combinations.

They vary from 1/10 to ½ H.P. with various motor speeds. Used with special heads for mica-undercutting, armature slot cleaning, etc. Complete line of attachments.

HAND TACHOMETER

Has speed range of 60 to 24,000 R.P.M. in 5 steps. Can be used in any position, is unaffected by direction of rotation, by magnetic lines, or by temperature changes. Gives instant speed reading without needle vibration. Has rubber tired wheel for surface speed of belts, fly wheels, etc.

ELECTRIC ETCHERS

4 Models to permanently etch ferrous metal items as easily as writing with a pencil. All 4 have adjustable heat ranges to suit requirements of the job.

DEMAGNETIZER MODEL D-3

This tool quickly and easily removes magnetism from cutting tools such as cutters, drills, saws, etc. and thus keeps them free from chips and metal-slivers that reduce production. Cuts cost of tool maintenance.

PORTABLE ELECTRIC BLOWERS

3 More Powerful New Models for blowing and vacuum cleaning
¼ - 1 - 1½ H.P.
Write for full particulars

DUST MASKS

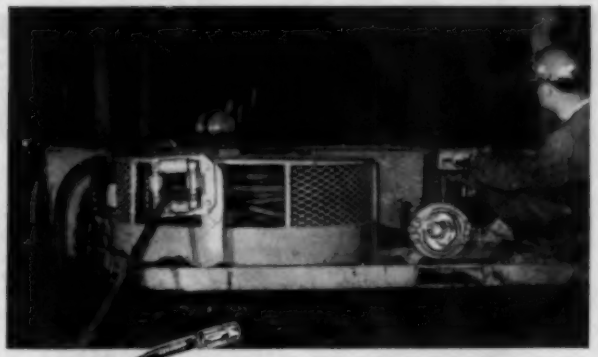
Weigh less than 2/5 oz.
Workers like Martindale Masks because they are light, comfortable, convenient, sanitary, and effective against non-toxic dusts.
List Prices: Casks $.30 ea.

#1 Refills $.02 ea. Quantity Discounts for $10.00 list and over. Write for Bulletin 355.

WRITE FOR COMPLETE 64-PAGE CATALOG.

Aeroquip Bulk Hose and Reusable Fittings Speed Field Replacement

Make all your replacement lines quickly, easily, with Aeroquip Bulk Hose and Reusable Fittings. Just cut the length of hose needed and attach the fittings using ordinary shop tools. A few coils of Aeroquip Bulk Hose and some reusable fittings are all you need to replace hose lines on all kinds of mining equipment. Call the Aeroquip Distributor listed in your local Yellow Page Directory.



Aeroquip Hose Lines are made to withstand the abrasion, shock and rough usage in the mine.

SELECT THE HOSE THAT FITS YOUR NEEDS

MEDIUM PRESSURE COTTON COVERED HOSE

Single wire braid 1503 Hose with oil and mildew resistant cotton braid cover is recommended for hydraulic lines up to 3000 psi. Ideal for fuel, oil, air and water lines, too. In sizes from ¼" to 2½".

COAL SHOOTING PNEUMATIC HOSE

Multiple wire braid 1509A Hose with synthetic armorite cover (or 2759 Hose with perforated rubber cover) is especially designed for coal shooting operations. Standard 3/8" size with male flare fittings.

HIGH PRESSURE HYDRAULIC HOSE

Double wire braid 1509 Hose with tough rubber cover is recommended for all high pressure hydraulic lines up to 5000 psi., depending on size. In sizes from ¼" to 2".

MEDIUM PRESSURE RUBBER COVERED HOSE

Single wire braid 2651 Hose with abrasion, oil and mildew resistant rubber cover. For hydraulic, oil, fuel, air and water lines up to 3000 psi. No skiving is necessary. Fittings fit right over hose cover. ¼" to 2½".

SELF-SEALING COUPLINGS

Aeroquip 5100 Self-Sealing Couplings connect and disconnect hydraulic, fuel, oil and air lines quickly, with no loss of fluid or inclusion of air or foreign matter into the system. Valve faces are easy to clean. Sizes ¼" to 1¼".

EQUIPMENT MANUFACTURERS

Write for Catalog No. 201 for full information on Aeroquip products plus helpful engineering data.

Aeroquip

REG. TRADEMARK

AEROQUIP CORPORATION, JACKSON, MICHIGAN

IN CANADA: AEROQUIP (CANADA) LTD., TORONTO 10, ONTARIO

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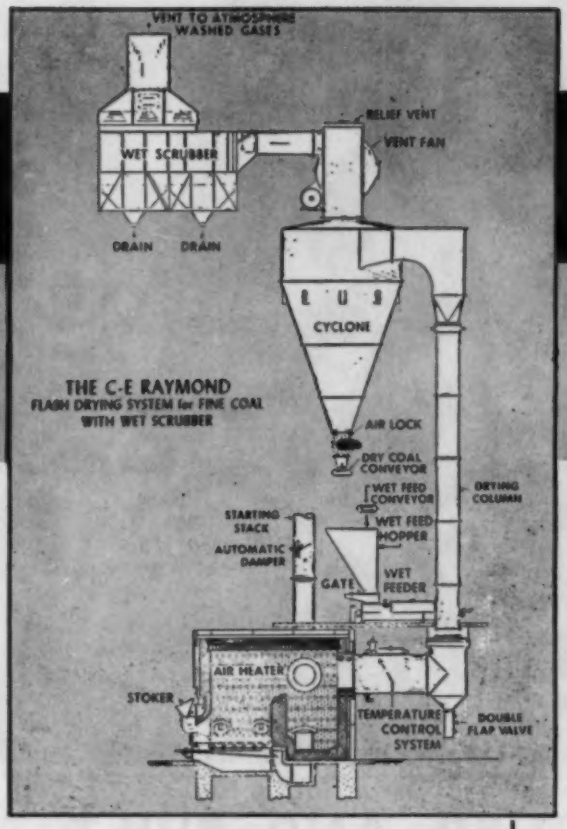

Flow sheet diagram of C-E Raymond Flash Drying System for fine coal, with wet scrubber.

NEW DEVELOPMENTS

C-E COAL TRAP

Degradation in the C-E Flash Drying System is of no consequence for most coal.
For soft coals, the C-E System is equipped with the C-E Coal Trap to eliminate degradation.

C-E DEDUSTING SYSTEM

This system now under development extracts the ultra-fine dust from the vent, and burns it in the furnace to produce heat for drying.

EXCLUSIVE

Advantages of C-E Raymond *Flash Drying System*

1. **Wide Capacity Range**
   From 10 to 100 tons per hour per column. Up to four columns per furnace.

•

2. **Flexible Design**
   Will fit plant layout without costly alterations. Eliminates costly coal elevator equipment.

•

3. **Lowest Building Cost**
   Vertical design requires minimum floor space. Outside construction may be used to fullest extent.

•

4. **Instantaneous (Flash) Drying is Inherently Safe**
   There is only a small quantity of coal in the system at any given time.

•

5. **Flash Drying Gives Uniform Final Moisture**
   (Especially important for Metallurgical Coals). Small quantity of coal in system results in immediate response to wet feed changes.

For further details,
write for Bulletin FD-51

COMBUSTION ENGINEERING, INC.
Raymond Division

1315 North Branch St.
Chicago 22, Illinois

Sales Offices in Principal Cities

Combustion Engineering-Superheater Ltd., Montreal, Canada

DESIGNED AND BUILT THE ALLEN & GARCIA WAY

"TOP OF THE FIELD"

DESIGN · BUILD · OPERATE

SCOPE OF A & G SERVICES

- Design and construction of new plants and their various units.
- Organization, operation and management of mines.
- Reconstruction, revamping and improvement of existing plants.
- Below ground modernization and mechanization.
- General consulting work on power, equipment, operation and varied mining problems.
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- Reports and Appraisals.

COMPLETE RESPONSIBILITY FOR SUCCESSFUL OPERATION

Should you ever want to start from unworked earth . . . . and take over a completed mine with a record of more than a year of profitable operation . . . . simply put the complete responsibility up to "A & G" . . . . as was done in this case. This is just one example from scores of A & G mining operations, including new projects and modernization of old properties. We have no set "formula" . . . . every assignment is treated as a separate new problem. We are unhampered by any associations or affiliations, and have absolutely no "axe to grind" for any manufactured product. That is why we can so successfully serve our clients.

ALLEN & GARCIA CO.

Consulting and Construction Engineers

332 S. MICHIGAN AVE., CHICAGO 4, ILL.

The 1957 Coal Age Mining Guidebook . . .

Buying Directory

Equipment . . . Materials . . . Services

Who Supplies It?

EQUIPMENT, MATERIALS AND SERVICES FOR COAL MINING, together with the names of those who furnish them, are shown in Part 1 of this Buying Directory, starting on the next page.

All products, materials and services, with their suppliers in each instance, are listed alphabetically under the key words. For example, look for "Bearings, Roller," rather than "Roller Bearings." If a product does not appear under one possible classification—for example, "Cable, Welding"—look for the alternative listing—in this instance, "Welding, Cable."

TRADE NAMES—Where trade names have been provided by manufacturers, they are shown following the manufacturers' names under the appropriate product headings as an additional aid in locating sources of supply.

PRODUCT INFORMATION—The names of manufacturers and suppliers providing more detailed data on available equipment, materials and services through speed product-information advertisements in this issue are shown in **BLACK-FACED TYPE.** To locate the advertisement of a specific manufacturer, consult the Advertising index on p 368 of this issue, or the Directory of Manufacturers beginning on p 344.

Where Are They?

THE ADDRESSES of the manufacturers, suppliers and service organizations appearing in the Buying Directory are listed under the company names in the Directory of Manufacturers beginning on p 344 of this issue.

EXTRA IN 1957—For added convenience in obtaining equipment, services and materials offered by advertisers in this issue, their sales offices and representatives are shown by states in the Advertiing Index beginning on p 352.

The 1957 Coal Age Mining Guidebook . . .

Buying Directory

Equipment . . . Materials . . . Services

Bold-faced type indicates a product-information advertisement in this issue. To locate, see Advertising Index, p 368, or Directory of Manufacturers, beginning on p 344.

ACCOUNTING MACHINES
Talier & Cooper

ACETYLENE GENERATORS
Air Reduction Sales Co., Div. of Air Reduction Co., Inc.
Marathon Coal Bit Co. Inc.—"AIRCO"
The Sight Feed Generator Co.—"SIGHT FEED"
Victor Equipment Co.

ACTUATORS, CYLINDER, LINE VALVES
Ledeen Mfg. Co.

ADDING MACHINES
Geo-Optic Co., Inc.

ADDITIVES, FUEL-OIL
Warren Refining & Chemical Co.—"PVR"

ADDITIVES, LUBRICANT
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E. I. du Pont de Nemours & Co., Inc.
Shell Oil Co.
Stewart-Warner Corp., Alemite Div.
Warren Refining & Chemical Co.—"PVR"

ADHESIVES
B. F. Goodrich Industrial Products Co.—"PLASTILOCK," "VULCALOCK," "DUO-LOCK"

AERATORS, BIN
Bin-Dicator Co.—"BIN-FLO"
Convair

AERIAL PHOTOS
Aero Service Corp.
American Air Surveys, Inc.

AERIAL PLATFORMS
Pitman Manufacturing Co.—"GIRAFFE"

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American Air Surveys, Inc.
Jack Ammann Photogrammetric Engineers, Inc.
Fairchild Aerial Surveys, Inc.
Geo-Optic Co., Inc.

AERIAL TRAMWAYS
Interstate Equipment Div., Yara Engineering Corp.

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Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Worthington Corp.

AGITATOR CONDITIONERS
The Daniels Co., Contractors, Inc.
Elmco Corp.
Western Machinery Co. — "WEMCO"

AGITATORS, FLUID
Philadelphia Gear Works

AIR CLEANERS, COAL
Jeffrey Mfg. Co.
Link Belt Co., Dept. CAMGL-57
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"
Stephens-Adamson Mfg. Co.—"AIR-SAND"

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AIR COMPRESSORS, CENTRIFUGAL
American Blower, Div. of American Standard

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Cardox Corp.—"AIRDOX"
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Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.—"MINEAIR"
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Worthington Corp.

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Chicago Pneumatic Tool Co.
Davey Compressor Co.
Gardner-Denver Co.
Imperial - Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Joy Mfg. Co. — "UNITAIR," "AIRVANE"
Le Roi Div., Westinghouse Air Brake Co.
Manu-Mine Research & Development Co.
Morse Bros. Machinery Co.
Schramm, Inc.
Worthington Corp.

AIR COMPRESSORS, SELF-PROPELLED
Acme Machinery Co.
Davey Compressor Co.
Goodman Mfg. Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Morse Bros. Machinery Co.
Schramm, Inc.
Worthington Corp.

AIR COMPRESSORS, STATIONARY
Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"RO-FLO"
Cardox Corp.—"AIRDOX"
Chicago Pneumatic Tool Co.
Davey Compressor Co.
Emglo Products Div., M. Glosser & Sons Inc.—"EMGLO"
Gardner-Denver Co.
Imperial-Cantrell Mfg. Co.—"CANTRELL"
Ingersoll-Rand Co.
Joy Mfg. Co.—"INDUSTRIAL AIR"
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Morse Bros. Machinery Co.
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Penn Machine Co.
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American Blower, Div. of American Standard.

AIR-LINE FILTERS
Snap-on Tool Corp.

AIR-LINE OILERS
Acme Machinery Co.
The Branford Co. — "BRANFORD"
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Davey Compressor Co.
Gardner-Denver Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Mall Tool Co. — "MALL," "REMINGTON"
R. W. Nichols Co.—"M-B"
Schroeder Bros. Corp.
Stewart-Warner Corp., Alemite Div.
Thor Power Tool Co.
Victor Equipment Co.

AIR RECEIVERS
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
L. O. Koven & Bros., Inc.
Pennsylvania Pump & Compressor Co.
Worthington Corp.

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Gruendler Crusher & Pulverizer Co.
Hardinge Co., Inc.
Majac, Inc.
Mechanical Industries, Inc.
New Jersey Meter Co.—"DRI-AIR"
Universal Road Machinery Co.
Western Precipitation Corp. — "MULTICLONE"
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Foxboro Co.
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ALIDADES, PLANETABLE
Kern Instruments, Inc.

ALLOYS, NICKEL
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U. S. Safety Service Co.—"SAF-I-LENS"
Willson Products Div., Ray-O-Vac Co.

ANTIFREEZE
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E. I. du Pont de Nemours & Co., Inc.—"ZERONE," "ZEREX"

ARCHES, SUSPENDED FURNACE
Bigelow-Liptak Corp.

ARMATURE GROWLERS, TESTERS
Martindale Electric Co.
Snap-on Tools Corp.

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Flood City Brass & Electric Co.
Guyan Machy. Co.
National Mine Service Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
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Martindale Electric Co.

ASHING EQUIPMENT, RAPID
Laboratory Equipment Co.

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Salem Tool Co.

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Compton, Inc.
Link-Belt Co., Dept. CAMGL-57
Marathon Coal Bit Co. — "SALEM"
Metallurgical Products Div., General Electric Co.—"CARBOLOY"
Salem Tool Co.
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Dooley Bros.
Kennametal Inc.
Marathon Coal Bit Co. — "McLAUGHLIN"
McLaughlin Mfg. Co., Inc.
Metallurgical Products Dept., General Electric — "CARBOLOY"
Mobile Drilling Inc.
Salem Tool Co.
Schroeder Bros. Corp.

AUGERS, EARTH
Acker Drill Co. Inc.—"ALL-PURPOSE (AP) DIGGER"
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Four Wheel Drive Auto Co.
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Leetonia Tool Co.
Link-Belt Co. Dept CAMGL—57
Mall Tool Co. — "MALL," "REMINGTON"
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Link-Belt Co., Dept. CAMGL-57
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Bemis Bro. Bag Co.—"FLIP-CLOSE"
Elmco Corp.
Peterson Filters & Engineering Co.—"SARAN"
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Fulton Bag & Cotton Mills
Mine Safety Appliances Co.
National Powder Co.
The Salem Tool Co.
Tamping Bag Co. Div., Pickard Industries, Inc.

BAGS, TAMPING
American Cyanamid Co., Explosives Dept.
Atlas Powder Co.
Bemis Bro. Bag Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Fulton Bag & Cotton Mills
King Powder Co., Inc.
National Mine Service Co.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.
Tamping Bag Co., Div., Pickard Industries, Inc.

BAGS, WATERPROOF
Bemis Bro. Bag Co.

BALL MILLS LABORATORY
Mount Sopris Instrument Corp.

BALLS, STEEL
New Departure Div., General Motors Corp.
SKF Industries, Inc.

BARGE-HANDLING EQUIPMENT
Connellsville Mfg. & Mine Supply Co.
Dravo Corp.
Hewitt-Robins Incorporated.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Stephens-Adamson Mfg. Co.

BARGES
Bethlehem Steel Co.
Dravo Corp.
Marietta Mfg. Co.
Wiley Mfg. Co.

BAROMETERS
American Paulin System
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
General Scientific Equipment Co.

BAROMETERS, ALTITUDE
Charles Bruning Co., Inc.

BARS, APPLICATOR
Stulz - Sickles Co. — "MANGANAL"

BARS, GRIZZLEY

Colorado Fuel & Iron Corp. "C F & I"

BARS, SLATE

Duquesne Mine Supply Co.
Leetonia Tool Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
The Salem Tool Co.

BASKETS, CLOTHES

C. R. Daniels Co.
The Moore Co.

BATTERIES, DRY

United States Rubber Co.

BATTERIES, STORAGE

C & D Batteries, Inc.—"SLYVER - CLAD," "PLASTICELL," "PLASTICAL"
Compton, Inc.
Thomas A. Edison Industries, McGraw-Edison Co., Storage Battery Div.—"EDISON"
Exide Industrial Div., Electric Storage Battery Co. — "EXIDE-IRONCLAD," "EXIDE POWERCLAD"
Goodyear Tire & Rubber Co.
Gould-National Batteries, Inc.
Graybar Elec. Co., Inc.
Kersey Mfg. Co., Inc.
National Mine Service Co.
Seiberling Rubber Co.
Yardney Electric Corp. — "YARDNEY SILVERCEL," "YARDNEY SILCAD"

BATTERY-CHARGING EQUIPMENT

Cornell-Dubilier Electric Co. — "POWERCON"
The Electric Products Co.
Exide Industrial Div., Electric Storage Battery Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
General Scientific Equipment Co.
Gould-National Batteries, Inc.
Hobart Bros. Co.
Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
Kersey Mfg. Co., Inc.
Lincoln Electric Co.—"PRECISION-CHARGE"
Mine Safety Appliances Co.
Syntron Co.
Westinghouse Electric Corp.

BATTERY TEST CLAMPS

General Scientific Equipment Co
Graybar Elec. Co., Inc.

BEARING METAL

American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO METAL"
Bearings, Inc.
Crucible Steel Co. of America
Imperial-Cantrell Mfg. Co.—"IC"
Johnson Bronze Co.
Leman Machine Co.
Joseph T. Ryerson & Son, Inc.
Webster Mfg., Inc.
West Virginia Armature Co.

BEARING OILERS

Herold Mfg. Co.

BEARINGS, BALL

Ahlberg Bearing Co.—"AHLBERG"
Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
Continental Gin Co.
Dodge Mfg. Corp.—"SC," "SLP" "SCM"
Ensign Electric & Mfg. Co.
The Fafnir Bearing Co.
The Federal Bearings Co., Inc.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Link-Belt Co.—Dept. CAMGL-57—"JPS"
Marlin - Rockewell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
New Departure Div., General Motors Corp.
Norma-Hoffman Bearings Corp.
SKF Industries, Inc.
Ore Reclamation Co.
Stephens-Adamson Mfg. Co.—"SEALMASTER"
Torrington Co.
Transall, Inc.
T. B. Woods Sons Co.
West Virginia Armature Co.

BEARINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Link-Belt Co., Dept. CAMGL-57

BEARINGS, CARBON

Helwig Co.
Ohio Carbon Co.—"KARAK"
Pure Carbon Co., Inc.

BEARINGS, HANGER

Vickers, Inc.—"TULSA (Two speed)"

BEARINGS, JOURNAL

American Brake Shoe Co., National Bearing Div.
American Brake Shoe Co., Railroad Products Div.

BEARINGS, NEEDLE

Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc
McGill Mfg. Co., Inc.—"MULTIROL," "CAMROL," "GUIDEROL"
Orange Roller Bearing Co., Inc.
Torrington Co.

BEARINGS, ROLLER

Bantam Bearings Div., Torrington Co.
Bearing Service Co.
Bearings, Inc.
Chain Belt Co.—"SHAFER"
Continental Gin Co.
Dodge Mfg. Corp.—"DODGE-TIMKEN," "SPHER-ALIGN"
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co., Dept. CAMGL-57—"LINK BELT," "MILL BEARING"
Marlin-Rockewell Corp.—"M-R-C"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Norma-Hoffmann Bearing Corp.
Orange Roller Bearing Co., Inc.
Ore Reclamation Co.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Torrington Co.
Tyson Bearing Corp., Sub. SKF Industries, Inc.
West Virginia Armature Co.

BEARINGS, ROLLER, SPLIT

Bearing Service Co.
Bearings, Inc.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co., Dept CAMGL-57
Transall, Inc.

BEARINGS, SLEEVE

American Crucible Products Co.
Allison Div., General Motors Corp.
American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO METAL"
Bearings, Inc.
Dodge Mfg. Corp.—"SLEEVOIL"
Flood City Brass & Electric Co.
Imperial-Cantrell Mfg. Co.—"IC"
Johnson Bronze Co.
Leman Machine Co.
Link-Belt Co., Dept CAMGL-57—"LINK-BELT"
Mosebach Electric & Supply Co.
Saginaw Bearing Co.—"SABECO"
Bertrand P. Tracy Co.
Transall, Inc.
Webster Mfg., Inc.
West Virginia Armature Co.

BEARINGS, SLEEVE, CONVERSION

Bearings, Inc.
Imperial-Cantrell Mfg. Co. —"I C"
Johnson Bronze Co.
West Virginia Armature Co.

BEARINGS, SLEEVE, SELF-LUBRICATING

Keystone Carbon Co.

BEARINGS, TAPERED ROLLER

The Timken Roller Bearing Co.

BEARINGS, THRUST

Bantam Bearings Div., Torrington Co.
Bearings, Inc.
Bearing Service Co.
Continental Gin Co.
Gibraltar Equipment & Mfg. Co.
The Federal Bearings Co., Inc.
Hyatt Bearings Div., General Motors Corp.
Johnson Bronze Co.
Link-Belt Co., Dept. CAMGL-57
Marlin-Rockewell Corp.—"M-R-C"
New Departure Div., General Motors Corp.
Norma-Hoffmann Bearing Corp.
Ore Reclamation Co.
Rollway Bearing Co., Inc.
SKF Industries, Inc.
Saginaw Bearing Co.—"SABECO"
Torrington Co.

BELT-LOADING STATIONS, AUTOMATIC

Nolan Co.

BELTS, CHAIN

Link-Belt Co., Dept. CAMGL-57

BELTS, FLAT TRANSMISSION

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
C. R. Daniels Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div. — "HIGH FLEX"
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.—"SUPER SERVICE"
Hewitt-Robins Incorporated
Manheim Mfg. & Belting Co.
New York Belting & Packing Co.—"TEST SPECIAL," "GILMER," "KABLE KORD
Ore Reclamation Co.
Quaker Rubber Div., H. K. Porter Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"CONDOR"
Republic Rubber Div., Lee Rubber & Tire Co.—"CHALLENGER"
Scandinavia Belting Co.—"SCANDINAVIA," "SCANDILEX"
Talcott, Inc.
Thermoid Co.
Transall, Inc.
United States Rubber Co.

BELTS, V

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"TEXROPE"
American Pulley Co.—"WEDGBELT"
Boston Woven Hose & Rubber Co.
Browning Mfg. Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Continental Gin Co.
Dodge Mfg. Corp.—"SEALEDLIFE"
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodrich Co., B. F., Industrial Products Div.—"GROMMET"
Goodyear Tire & Rubber Co.,
Guyan Machy. Co.
Industrial Rubber Products Co. —(Pa.)

Link-Belt Co., Dept. CAMGL-57
Mosebach Electric & Supply Co.
National Mine Service Co.
New York Belting & Packing Co.—"GILMER"
Ore Reclamation Co.
Quaker Rubber Div., H. K. Porter Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"CONDOR," "SUPER-POWER"
Republic Rubber Div., Lee Rubber & Tire Co.—"REPUBLIC"
Thermoid Co.
Transall, Inc.
United States Rubber Co.
T. B. Woods Sons Co.
Worthington Corp.

BELTS, V-LINK

Guyan Machy Co.
Manheim Mfg. & Belting Co.
National Mine Service Co.
New York Belting & Packing Co.—"GILLINK"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
T. B. Woods Sons Co.

BENDERS, PIPE, CONDUIT

Blackhawk Mfg. Co.
National Electric Products Co.

BENDERS, PIPE, BAR STOCK, ANGLE IRON, RIGID CONDUIT

Hossfeld Mfg. Co. — "HOSSFELD UNIVERSAL"

BINDERS, LOAD

Crosby Laughlin Div. American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN," "LEBUS"
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co.
Coffing Hoist Div., Duff-Norton Co.
Gibraltar Equipment & Mfg. Co.

BIN GATES

Blaw-Knox Co.
C. S. Card Iron Works
Chain Belt Co.—"REX"
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works—"TELSMITH"
Stephens-Adamson Mfg. Co.—"MOORE," "DUPLEX," "TRIPLEX"
Thomas Engineering & Construction Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

BIN-LEVEL INDICATORS

Bin-Dicator Co. — "BINDICATOR," "BANTAM BINDICATOR," "ROTO BINDICATOR"
Convair—"BIN-VUE"
Fairfield Engineering Co.
Hewitt-Robins Incorporated—"ROBINTRONIC"
Industrial Physics & Electronics Co.
Jeffrey Mfg. Co.
Stephens-Adamson Mfg. Co.—"TELLEVEL"

BIN VIBRATORS

Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Eriez Mfg. Co.
W. S. Tyler Co.—"TY-SPEED"

BINS, COAL STORAGE, BLENDING, SLATE

Neff & Fry Co.

BINS, PARTS-STORAGE

Frick-Gallagher Mfg. Co.
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

BINS & HOPPERS, COAL-STORAGE, BLENDING

Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
The Daniels Co., Contractors, Inc.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
L. O. Koven & Bro., Inc.
Link-Belt Co., Dept. CAMGL-57
Meckum Engr. Co.
R. C. Mahon Co.
Marietta Concrete Corp.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Thomas Engineering & Construction Co.
Universal Engineering Co.

BITS, CUTTER, ALLOY-STEEL

Bowdil Co.
Cardox Corp.
Central Mine Equipment Co.
Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX-TIPPED"
Crucible Steel Co. of America—"REX," "REXALLOY"
Cutter Bit Service Co.—"CUT-RITE"
H & L Tooth Co.
Marathon Coal Bit Co. Inc.—"CRUCIBLE"
Penn Machine Co.
Frank Prox Company, Inc.
Salem Tool Co.

BITS, CUTTER, CARBON-STEEL

Austin Powder Co.
Crucible Steel Co. of America
Cutter Bit Service Co.—"CUT-RITE"
Howells Mining Drill Co.
Joy Mfg. Co.
Leetonia Tool Co.
Marathon Coal Bit Co. Inc.—"UNION FORGE"
Salem Tool Co.

BITS, CUTTER, CARBIDE-INSERT-TIPPED

Allegheny Ludlum Steel Corp.
Austin Powder Co.
Bowdil Co.
Cincinnati Mine Machinery Co.—"CINIDE"
Cutter Bit Service Co.—"CUT-RITE"
Firth Sterling, Inc.—"FIRTH-ITE"
Guyan Machy. Co.
Hoffman Bros. Drilling and Mfg. Co.
Kennametal, Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"CARBOLOY"
Metal Carbides Corp.
Metallurgical Products Dept. General Electric Co.
Mobile Drilling Inc.
National Mine Service Co.
Newcomer Products, Inc.
Penn Machine Co.
Frank Prox Company, Inc.
Salem Tool Co.
W. J. Savage Co.—"CARBOLOY"
Vascoloy-Ramet Corp.

BITS, CUTTER, HARD-SURFACED, PLATED, TIPPED

Bowdil Co.

Cardox, Corp.
Central Mine Equipment Co.
Cutter Bit Service Co.—"CUT-RITE"
Mobile Drilling Inc.
Penn Machine Co.
Frank Prox Company, Inc.
Salem Tool Co.

BITS, CUTTER, HARD-SURFACED, TIPPED

Cincinnati Mine Machinery Co.—"CINCINNATI," "DUPLEX-TIPPED"

BITS, CUTTER, THROWAWAY

Bowdil Co.
Cardox Corp.
Central Mine Equipment Co.
Cincinnati Mine Machinery Co.—"DUPLEX," "STANEX"
Hoffman Bros. Drilling and Mfg. Co.
Marathon Coal Bit Co. Inc.—"MARATHON"
Mobile Drilling Inc.
National Mine Service Co.
Penn Machine Co.
Frank Prox Company, Inc.—"TOOL STEEL," "DUO"
Salem Tool Co.

BITS, DRILL, COAL

Austin Powder Co.
Cardox Corp.
Central Mine Equipment Co.
Compton, Inc.
Dooley Brothers
Gibraltar Equipment & Mfg. Co.
Herb J. Hawthorne, Inc.—"BLU DEMON"
Howells Mining Drill Co.
Kennametal Inc.
Marathon Coal Bit Co. Inc.—"McLAUGHLIN," "COAL-MASTER"
McLaughlin Mfg. Co., Inc.
Mobile Drilling Inc.
National Mine Service Co.
Newcomer Products, Inc.
Paris Mfg. Co.
Frank Prox Company, Inc.
Salem Tool Co.
Schroeder Brothers Corp.
Stardrill-Keystone Co.

BITS, DRILL, COAL, CARBIDE-TIPPED

Allegheny Ludlum Steel Corp.
Austin Powder Co.
Brunner & Lay, Inc.
Firth Sterling, Inc.—"FIRTH-ITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling and Mfg. Co.
Howells Mining Drill Co.
Kennametal, Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"CARBOLOY"
McLaughlin Mfg. Co., Inc.
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.
Mobile Drilling Inc.
Newcomer Products, Inc.
Paris Mfg. Co.
Frank Prox Company, Inc.
Salem Tool Co.
W. J. Savage Co.
Schroeder Brothers Corp.
Vascoloy-Ramet Corp.

BITS, DRILL, CHURN

Spang & Co.

BITS, DRILL, CORE

George E. Failing Co.
Hoffman Bros. Drilling and Mfg. Co.
Joy Mfg. Co.
Kennametal, Inc., Mining Tool Div.
E. J. Longyear Co.
Mobile Drilling Inc.
Newcomer Products, Inc.
Pennsylvania Drilling Co.
Sprague & Henwood
Varel Mfg. Co., Inc.

BITS, DRILL, CORE, DIAMOND, CARBIDE AND SHOT

Acker Drill Co. Inc.

BITS, DRILL, DIAMOND

George E. Failing Co.
Hoffman Bros. Drilling and Mfg. Co.
Joy Mfg. Co.—"TRUCO"
E. J. Longyear Co.
Metal Carbides Corp.
Mobile Drilling Inc.
Pennsylvania Drilling Co., Masonry Drill Div.

J. K. Smit & Sons—"HARD HED"
Sprague & Henwood
Varel Mfg. Co., Inc.

BITS, DRILL, DIAMOND, RESETTING SERVICE
Sprague & Henwood

BITS, DRILL, MASONRY
Pennsylvania Drilling Co., Masonry Drill Div.

BITS, DRILL, MOLEFOOT, STRIPPING
Cardox Corp.
Central Mine Equipment Co.
Marathon Coal Bit Co. Inc.—"McLAUGHLIN," "CARBOLOY"
Mobile Drilling Inc.
Paris Mfg. Co.
Salem Tool Co.

BITS, DRILL, PERCUSSION
Acme Machinery Co.
Brunner & Lay, Inc.
Bucyrus-Erie Co.
Gardner-Denver Company
Guyan Machy. Co.—"THROW-AWAY"
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Schroeder Brothers Corp.
Stardrill-Keystone Co.—"ACME"

BITS, DRILL, PERCUSSION, CARBIDE-INSERTS, MULTI-USE
The Timken Roller Bearing Co.

BITS, DRILL, PERCUSSION, CARBIDE-TIPPED
Allegheny Ludlum Steel Corp.
Brunner & Lay, Inc.—"ROK-BITS"
Joy Mfg. Co.
Ingersoll-Rand Co.
Kennametal, Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.
Metal Carbides Corp.
Newcomer Products, Inc.
B. J. Nykerk Corp.—"HAUSHERR"
Vascoloy-Ramet Corp.

BITS, DRILL ROOF-CARBIDE-TIPPED
Allegheny Ludlum Steel Corp.
Austin Powder Co.
Brunner & Lay, Inc.—"INTRA-SET"
Firth Sterling, Inc.—"FIRTH-ITE"
Guyan Machy. Co.—"FIRTH-ITE"
Kennametal, Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc—"CARBOLOY"
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.
Newcomer Products, Inc.
Frank Prox Company, Inc.
W. J. Savage Co.
Vascoloy-Ramet Corp.

BITS, DRILL, ROTARY, DRY, STRIPPING
Austin Powder Co.
Cardox Corp.
Central Mine Equipment Co.
Davey Compressor Co.
George E. Failing Co.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling and Mfg. Co.
Hughes Tool Co.
Kennametal Inc., Mining Tool Div.
Marathon Coal Bit Co. Inc.—"McLAUGHLIN," "CARBOLOY"
Mobile Drilling Inc.
Varel Mfg. Co., Inc.—"AIR-BLAST"

BITS, DRILL, ROTARY, DRY, STRIPPING, RENEWABLE-CONE
Central Mine Equipment Co.—"STRIPMASTER"

BITS, DRILL, ROTARY, WET, STRIPPING
Cardox Corp.
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Hoffman Bros. Drilling and Mfg. Co.
Hughes Tool Co.
Marathon Coal Bit Co. Inc.—"CARBOLOY"
Varel Mfg. Co., Inc.

BITS, DRILL, ROTARY, WET, CARBIDE-TIPPED, STRIPPING
Allegheny Ludlum Steel Corp.
Firth Sterling, Inc.—"FIRTH-ITE"
Herb J. Hawthorne, Inc.—"BLUE DEMON"
Marathon Coal Bit Co. Inc.—"CARBOLOY"
Metal Carbides Corp.
Metallurgical Products Dept., General Electric Co.
Varel Mfg. Co., Inc.
Vascoloy-Ramet Corp.

BITS, FINGER, CARBIDE-TIPPED
Firth Sterling Inc.—"FIRTH-ITE"
Vascoloy-Ramet Corp.

BITS, STRIP, FINGER, CARBIDE-TIPPED
Firth Sterling Inc.—"FIRTH-ITE"

BIT BOXES
Duquesne Mine Supply Co.

BIT-RESETTING SERVICE, DIAMOND
Hoffman Bros. Drilling and Mfg. Co.
Joy Mfg. Co.
J. K. Smit & Sons
Sprague & Henwood

BIT SHARPENERS, COAL BITS
Joy Mfg. Co.

BIT SHARPENERS, ROCK BITS
Bucyrus-Erie Co.
Hoffman Bros. Drilling and Mfg. Co.
Ingersoll-Rand Co.
Joy Mfg. Co.

BIT-SHARPENING SERVICE
Brunner & Lay, Inc.
Hoffman Bros. Drilling and Mfg. Co.
Howells Mining Drill Co.
Marathon Coal Bit Co. Inc.

BLASTING AGENTS
American Cyanamid Co., Explosives Dept.—"CYAMITE," "ACCOMITE"
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.—"NITRAMEX," "NITRAMITE," "NITRAMON"
Hercules Powder Co.
Illinois Powder Mfg. Co.—"GOLD MEDAL"
King Powder Co., Inc.

BLASTING CAPS
American Cyanamid Co., Explosives Dept.
Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
Illinois Powder Mfg. Co.—"GOLD MEDAL"
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

BLASTING MACHINES
American Cyanamid Co., Explosives Dept.
Atlas Powder Co.
Hercules Powder Co.

BLASTING METERS
Hercules Powder Co.

BLASTING WIRE
Atlas Powder Co

BLASTING WIRE, CORD
American Cyanamid Co., Explosives Dept.
Cornish Wire Co., Inc.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Kaiser Aluminum & Chemical Sales, Inc.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.
The Salem Tool Co.

BLOCK SIGNALS, AUTOMATIC
American Mine Door Co.
Nachod & U. S. Signal Co.

BLOCKS, CRANE-HOOK
Upson-Walton Co.

BLOCKS, MANILA-ROPE
Upson-Walton Co.

BLOCKS, WHEEL
Aldon Co.

BLOCKS, WIRE-ROPE
Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LEBUS"
Guyan Machy. Co.
Joy Mfg. Co.
Sauerman Bros., Inc.—"DURO-LITE"
Upson-Walton Co.

BLOWERS, CENTRIFUGAL
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Blower, Div. of American-Standard
Buffalo Forge Co.
E. K. Campbell Co.—"EKCCO"
Chelsea Fan and Blower Co., Inc.
Clarage Fan Co.
Coppus Engineering Corp.
Graybar Elec. Co., Inc.
Hartzell Propeller Fan Co.
Hauck Mfg. Co.
Ilg Electric Ventilating Co.—"ILG"
Ingersoll-Rand Co.
Jeffrey Mfg. Co.
Roots-Connersville Blower, Div. Dresser Industries, Inc.
Westinghouse Electric Corp.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLOWERS, CIRCULATING, DRAFT
Buffalo Forge Co.
E. K. Campbell Co.—"EKCCO"
Clarage Fan Co.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.—"AXIVANE"
Sanford Day Iron Works, Inc.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLOWERS, CLEANING, MAINTENANCE
American Mine Door Co.
Holub Industries, Inc.
Joy Mfg. Co.—"AXIVANE"
Martindale Electric Co.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLOWERS, JIG
Roots-Connersville Blower, Div. Dresser Industries, Inc.

BLOWERS, PORTABLE, MINE
American Blower, Div. of American Standard
Buffalo Forge Co.
Chelsea Fan and Blower Co., Inc.
Coppus Engineering Corp.—"VANO," "VENTAIR"
Herold Mfg. Co.
Jeffrey Mfg. Co.—"AERO-DYNE"
Joy Mfg. Co.—"AXIVANE"
Mine Safety Appliances Co.
Morse Bros. Machinery Co.
Roots-Connersville Blower, Div. Dresser Industries, Inc.
Westinghouse Electric Corp., B. F. Sturtevant Div.

BLOWERS, VENTILATING, GASOLINE, PORTABLE
Homelite. Div. Textron Inc.—"HOMELITE"

BLUEPRINT PAPER & CLOTHS
Keuffel & Esser Co.

BOILERS, HEATING, HOT-WATER

Axeman-Anderson Co.
L. O. Koven & Bro., Inc.

BOLT-HOLE CLEANERS

Mine Safety Appliances Co.—"M-S-A"

BOLTS

Bethlehem Steel Co.
Duquesne Mine Supply Co.—"REDIPT"
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Oliver Iron & Steel Corp.
Republic Steel Corp.—"REPUBLIC"
St. Louis Screw & Bolt Co.
Sheffield Div., Armco Steel Corp.

BOLTS, TRACK—See Rail Bolts

BONDS, RAIL—See Rail Bonds

BOOSTERS, AIR/OIL, SINGLE STROKE

Ledeen Mfg. Co.

BORING MILLS

Farrel-Birmingham Co., Inc.

BOX-CAR LOADERS

Eimco Corp.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works
Morse Bros. Machinery Co.
Stephens-Adamson Mfg. Co.—"SWIVELOADER," "SINDEN"

BOX-CAR UNLOADERS

Link Belt Co., Dept. CAMGL-57
Stephens-Adamson Mfg. Co.

BOXES, DETONATOR

J. V. Hammond Co.
King Powder Co., Inc.
Mine Safety Appliances Co.

BOXES, POWDER

E. I. du Pont de Nemours & Co., Inc., Explosives Div.
J. V. Hammond Co.
King Powder Co., Inc.
Mine Safety Appliances Co.

BOXES, POWDER, SAFETY WOOD

E. I. du Pont de Nemours & Co., Inc., Explosives Div.
J. V. Hammond Co.
King Powder Co., Inc.
Mine Safety Appliances Co.

BRACES, TRACK

Gibralter Equipment & Mfg. Co.

BRAKE BLOCKS

Irwin Foundry & Mine Car Co.
Johns-Manville—"J-M"
Raybestos Manhattan, Inc. Manhattan Rubber Div.
Thermoid Co.
Wagner Electric Corp.
S. K. Wellman Co.

BRAKE BLOCKS, WOOD

J. V. Hammond Co.
Irwin Foundry & Mine Car Co.

BRAKE FLUID, HYDRAULIC

United States Rubber Co.

BRAKE FRICTION, LINING

American Brake Shoe Co., American Brakeblok Div.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.—"J-M," "VELVETOUCH"
Johns-Manville—"J-M"
Mining Machine Parts Inc.
Raybestos Manhattan, Inc. Manhattan Rubber Div.
Thermoid Co.
Wagner Electric Corp.
S. K. Wellman Co.—"VELVE-TOUCH"

BRAKE SHOES, METALLIC

American Brake Shoe Co., Railroad Products Div.
Duquesne Mine Supply Co.
Flood City Brass & Electric Co.
Gibralter Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Irwin Foundry & Mine Car Co.
National Mine Service Co.

BRAKES, LININGS

S. K. Wellman Co.—"VELVE-TOUCH"

BRAKES, LOCOMOTIVE

Goodyear Tire & Rubber Co.
Helmick Foundry-Machine Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.

BRAKES, LOWERING-CONVEYOR

Vulcan Iron Works

BRAKES, MAGNETIC

Clark Controller Co.
Cutler-Hammer, Inc.
Dings Magnetic Separator Co.
General Electric Co., Apparatus Sales Div.
Square D Co.
Trombetta Solenoid Corp.
Westinghouse Electric Corp.

BRAKES, MAGNETIC, EDDY-CURRENT

Dynamatic Div. Eaton Mfg. Co.
Square D Co.

BRAKES, MINE-CAR

American Car & Foundry Div. ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibralter Equipment & Mfg. Co.
Goodyear Tire & Rubber Co.
Helmick Foundry-Machine Co.
Irwin Foundry & Mine Car Co.

BRAKES, MOTOR

Master Electric Co.

BRAKES, TRUCK, AIR

Eaton Mfg. Co., Axle Div.
The Four Wheel Drive Auto Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Wagner Electric Corp.

BRAKES, TRUCK, HYDRAULIC

The Four Wheel Drive Auto Co.
Timken Detroit Axle Div., Rockwell Spring & Axle Co.
Wagner Electric Corp.

BRAKES, TRUCK, MECHANICAL

Timken Detroit Axle Div., Rockwell Spring & Axle Co.

BRATTICE CLOTH

American Brattice Cloth Corp.
C. R. Daniels Co.
John Flocker & Co.—"MOROPA"
Fulton Bag & Cotton Mills General Office, Bag Div. —"BLAZE BREAKER," "FFFF"
Goodrich Co., B. F., Industrial Products Div.-"KOROSEAL"
National Mine Service Co.

BREAKERS, AIR-PICK, FOR COAL

Le Roi Div., Westinghouse Air Brake Co.

BREAKERS, COAL REVOLVING

American Steel Foundries—"WEARPACT"
Heyl & Patterson, Inc.—"BRADFORD"
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.

BREAKERS, IMPACT

Pioneer Engineering, Div. of Poor & Co.

BREAKERS, PICK-TYPE, PREPARATION

McNally-Pittsburg Mfg. Corp.

BREAKERS, PAVING

Cleco Div., Reed Roller Bit Co.
Gardner-Denver Company
Homelite, Div. Textron Inc.—"HOMELITE (BOSCH)"
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div. Westinghouse Air Brake Co.
Marathon Coal Bit Co. Inc.—"IRON CITY"
Syntron Co.
Thor Power Tool Co.

BREATHING APPARATUS

Mine Safety Appliances Co.—"CHEMOX," "McCAA TWO-HOUR"

BRIDGES, COAL HANDLING

Heyl & Patterson, Inc.
Dravo Corp.
Link-Belt Co., Dept. CAMGL-57

BRUSH HOLDERS

Helwig Co.
Link-Belt Co., Dept. CAMGL-57
National Mine Service Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

BRUSHES, CARBON

Flood City Brass & Electric Co.
Guyan Machy. Co.
Helwig Co.
Keystone Carbon Co.
National Carbon Co., Div. of Union Carbide Corp.
National Mine Service Co.
Ohio Carbon Co.
Pure Carbon Co., Inc.
Speer Carbon Co.
Stackpole Carbon Co.
Standard Carbon Co.
Superior Carbon Products, Inc.
West Virginia Armature Co.
Westinghouse Electric Corp.

BUCKET CHAINS, DRAGLINE

Kensington Steel, Div. of Poor & Co.
Link-Belt Co., Dept. CAMGL-57

BUCKET TEETH, BASES, INSERTS

American Brake Shoe Co., Amsco Div.—"AMSCO"
American Steel Foundries—"WEARPACT"
Blaw-Knox Co.
Bucyrus-Erie Co.
Electric Steel Foundry Co.
H & L Tooth Co.
Kensington Steel, Div. of Poor & Co.
Page Engineering Co.
Taylor-Wharton Co., Div. Harsco Corp.

BUCKET-TEETH REPOINTERS

American Brake Shoe Co., Amsco Div.—"AMSCO"
Kensington Steel, Div. of Poor & Co.

BUCKETS, AERIAL TRAMWAY

Irwin Foundry & Mine Car Co.
Watt Car & Wheel Co.

BUCKETS, CLAMSHELL

Blaw-Knox Co.
Electric Steel Foundry Co.
George Haiss Mfg. Co., Div. Pettibone Mulliken Corp.
Koehring Co.
Orton Crane & Shovel Co.
Salem-Brosius, Inc.
Schield Bantam Co.
Wellman Engineering Co.

BUCKETS, CONVEYOR, ELEVATOR

American Brake Shoe Co., Amsco Div.—"AMSCO"
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Fairfield Engineering Co.
Gibraltar Equipment & Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Hewitt-Robbins Incorporated
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Koehring Co.
Kremser & Sons, Inc., Frank A.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
"LINK-BELT"
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Ore Reclamation Co.

Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
W. J. Savage Co.
Smith Engineering Works
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Transall, Inc.
Universal Engineering Co.
Universal Road Machinery Co.
Watt Car & Wheel Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

BUCKETS, DRAGLINE

Bucyrus-Erie Co.
Electric Steel Foundry Co.
Hendrix Mfg. Co.
Page Engineering Co.—"AUTOMATIC"
Quick-Way Truck Shovel Co.
Sauerman Bros., Inc.
Schield Bantam Co.
Taylor-Wharton Co., Div. Harsco Corp.
Wellman Engineering Co.

BUCKETS, DRAGLINE—ARCHES, CHAINS, FITTINGS

Bucyrus-Erie Co.
Electric Steel Foundry Co.
Hendrix Mfg. Co.
Page Engineering Co.

BUCKETS, DRILL-DUST

Mine Safety Appliances Co.—"DRIL-DUST"

BUCKETS, DUMP

Salem-Brosius, Inc.

BUCKETS, ELEVATOR

Pioneer Engineering, Div. of Poor & Co.

BUGDUSTERS, AUTOMATIC

Goodman Mfg. Co.
Joy Mfg. Co.

BUILDINGS, PREENGINEERED, STEEL, ALUMINUM

Butler Mfg. Co.

BUILDINGS, PREFAB

Armco Drainage & Metal Prod., Inc.
Arrowhead Steel Buildings, Inc.
Republic Steel Corp.—"TRUSCON"
Steel-Bilt Construction Co.
Steelcraft Mfg. Co.
Thomas Engineering & Construction Co.

BULLDOZER CORNER ADAPTERS

H & L Tooth Co.

BULLDOZER CORNER BITS

American Brake Shoe Co., Amsco Div.
Kensington Steel, Div. of Poor & Co.

BULLDOZER & GRADER BLADES

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Brake Shoe Co., Amsco Div.
American Steel Foundries—"WEARPACT"
Caterpillar Tractor Co.
Colorado Fuel & Iron Corp.—"C F & I"
Electric Steel Foundry Co.
Gar Wood Industries, Inc.
The Frank G. Hough Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.
Oliver Corp.—"OLIVER"

BULLDOZER RIPPER TEETH

American Brake Shoe Co., Amsco Div.

BULLDOZERS

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
J. I. Case Co.—"CASE-TERRA-TRAC"
Caterpillar Tractor Co.
Elmco Corp.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.—"TOURNA-TRACTOR"

BULLETIN-BOARD SERVICE

Elliott Service Co., Inc.

BUMPERS, LOCOMOTIVE

Gibraltar Equipment & Mfg. Co.
Kanawha Mfg. Co.
Leman Machine Co.
Thomas Engineering & Construction Co.
West Virginia Armature Co.

BUMPERS, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.
West Virginia Armature Co.

BUMPERS, RUBBER

Continental Rubber Works

BUS BAR, ELECTRICAL, ALUMINUM

Reynolds Metals Co.

BUSES, ELECTRIC

Delta-Star Electric Div., H. K. Porter Co. (Delaware)
I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

BUSES, AUTOMOTIVE, DIESEL-ENGINED

Mack Trucks, Inc.

BUSHINGS, BRONZE

American Brake Shoe Co., National Bearing Div.
Ampco Metal, Inc.—"AMPCO METAL"
Bearings, Inc.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Imperial-Cantrell Mfg. Co.—"IC"
Jeffrey Mfg. Co.
Johnson Bronze Co.
Keystone Carbon Co.
Leman Machine Co.
Marathon Coal Bit Co. Inc.—"NAIL CITY"
Penn Machine Co.
Saginaw Bearing Co.—"SAB-ECO"
Bertrand P. Tracy Co.
Walworth Co.

BUSHINGS, ELECTRICAL

Imperial-Cantrell Mfg. Co.—"IC"
National Electric Products Co.
Ohio Brass Co.
Superior Carbon Products, Inc.

BUSHINGS, IRON

Keystone Carbon Co.

BUSHINGS, RUBBER

United States Rubber Co.

CABLE, ALUMINUM

Reynolds Metals Co.

CABLE, ARMORED

General Cable Corp.
Rockbestos Products Corp.

CABLE, ASBESTOS-COVERED

American Steel & Wire—"AMERBESTOS"
Collyer Insulated Wire Co.
Ensign Electric & Mfg. Co.
John Flocker & Co.
Flood City Brass & Electric Co.
General Cable Corp.—"SAFETY M1"
Graybar Elec. Co., Inc.
Guyan Machy. Co.
National Electric Products Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Rockbestos Products Corp.—"ROCKBESTOS A.V.C."
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Triangle Conduit & Cable Co. Inc.

CABLE, ELECTRICAL

Schroeder Brothers Corp.

CABLE, FEEDER, BARE, STRANDED

Aluminum Company of America
American Steel & Wire—"TIGER BRAND"
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
Cooke-Wilson Electric Supply Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Rome Cable Corp.
Triangle Conduit & Cable Co. Inc.

CABLE, FEEDER, COPPER, BARE AND STRANDED

Phelps Dodge Copper Products Co.
Rome Cable Corp.

CABLE, FEEDER, COPPER AND COPPER CLAD, BARE AND STRANDED

American Steel & Wire—"TIGER BRAND"
Circle Wire & Cable Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
National Mine Service Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Triangle Conduit & Cable Co. Inc.

CABLE, INSULATED, BOREHOLE

American Steel & Wire—"TIGER BRAND"
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
National Mine Service Co.
Okonite Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co. Inc.

CABLE, INSULATED, COMMUNICATION, CONTROL

American Steel & Wire—"TIGER BRAND"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co.—"ANKOSEAL"
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
Fenco, Inc.
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
National Electric Products Co.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Rockbestos Products Corp.—"ROCKBESTOS P.N.R."

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Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
John Flocker & Co.
Flood City Brass & Electric Co.
General Cable Corp.—"GEN-CORONE," "BUTARONE"
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
The Kerite Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Okonite Co.
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Rome Cable Corp.
Simplex Wire & Cable Co.
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Aluminum Company of America
American Steel & Wire — "TIGER BRAND"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co. —"ANKOSEAL"
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPER-WELD"
John Flocker & Co.
Flood City Brass & Electric Co.
General Cable Corp.—"SUPER-SHEATH," "GUARDIAN"
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
The Kerite Co.
Mosebach Electric & Supply Co.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co. Inc.

CABLE, INSULATED, SUBMARINE

American Steel & Wire—"AMARINE"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co. —"ANKOSEAL"
John Flocker & Co.
General Cable Corp.
Guyan Machy. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Okonite Co.
Phelps Dodge Copper Products Co.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co. Inc.

CABLE, LEAD-SHEATHED

General Cable Corp.
Rockbestos Products Corp.

CABLE, REWIRING

National Mine Service Co.

CABLE, SHOTFIRING

American Cyanamid Co., Explosives Dept.
American Steel & Wire — "TIGER BRAND"
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
John Flocker & Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
King Powder Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosives Div.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Rome Cable Corp.
The Salem Tool Co.
Simplex Wire & Cable Co.

CABLE, TELEPHONE

American Steel & Wire — "TIGER BRAND"
Anaconda Wire & Cable Co.
The Ansonia Wire & Cable Co.—"ANKOSEAL"
John Flocker & Co.
General Cable Corp.—"SUPER-TEL"
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.

CABLE, TRAILING, 2,200 V AND UP

American Steel & Wire — "AMERCLAD"
Anaconda Wire & Cable Co .
Circle Wire & Cable Corp.
John Flocker & Co.
General Cable Corp.—"SUPER-SERVICE"
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
Simplex Wire & Cable Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Triangle Conduit & Cable Co. Inc.

CABLE, TRAILING, UNDERGROUND MINING UNITS

American Steel & Wire— "AMERCLAD"
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Ensign Electric & Mfg. Co.
John Flocker & Co.
Flood City Brass & Electric Co.
General Cable Corp.—"SUPER-SERVICE"
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Okonite Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.
Triangle Conduit & Cable Co. Inc.

CABLE ACCESSORIES, HIGH VOLTAGE

G & W Electric Specialty Co.
Graybar Elec. Co., Inc.
Ohio Brass Co.

CABLE ASSEMBLIES

Bergen Wire Rope Co.

CABLE CLAMPS

Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Graybar Elec. Co., Inc.
Holub Industries, Inc.
Ohio Brass Co.
Ore Reclamation Co.

CABLE CONNECTORS, ELECTRICAL

Anaconda Wire & Cable Co.
Albert & J. M. Anderson Mfg. Co.—"EITHEREND"
Burndy Corp.—"HYLUGS," "HYLINKS"
Crouse-Hinds Co.
Delta-Star Electric Div., H. K. Porter Co., (Delaware)
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Erico Products, Inc.—"CAD-WELD"
Ensign Electric & Mfg. Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Joy Mfg. Co.
Magnetic Engrg. & Mfg. Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Ohio Brass Co.
Tweco Products, Inc.—"SOL-CON," "MECCON"
West Virginia Armature Co.

CABLE CONTROLS

Caterpillar Tractor Co.

CABLE FAULT-FINDERS, PROOF TESTERS

Electrical Distributors Co.

CABLE HANGERS

American Mine Supply Co.
Graybar Elec. Co., Inc.
Ohio Brass Co.

CABLE PROTECTORS

Standard Devices Co.

CABLE REELS, LOCOMOTIVE

General Electric Co., Apparatus Sales Div.
Jeffrey Mfg. Co.
West Virginia Armature Co.

CABLE REELS, MINING-MACHINE, SHUTTLE CAR

Dooley Brothers
Jeffrey Mfg. Co.

CABLE REELS, SHOTFIRING

J. V. Hammond Co.
King Powder Co., Inc.

CABLE, TRAILING, SHOCK ABSORBERS

Mosebach Electric & Supply Co.

CABLE SPLICERS

American Mine Door Co.— "QUICK-ON"
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CAD-WELD"
Flood City Brass & Electric Co.
G & W Electric Specialty Co.
Graybar Elec. Co., Inc.
Mine Safety Appliances Co.— "VELOCITY-POWER"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Tweco Products, Inc.— "TWECO"
West Virginia Armature Co.

CABLE SUPPORTS, BOREHOLE

Ohio Brass Co.

CABLE SUPPORTS, HORIZONTAL RUNS

Delta-Star Electric Div., H. K. Porter Co. (Delaware)
The Elreco Corp.—"ELRECO"
Ohio Brass Co.

CABLE VULCANIZERS

American Mine Door Co.— "SHALER"
Flood City Brass & Electric Co.
Joy Mfg. Co.
Mine Safety Appliances Co.
Mosebach Electric & Supply Co.

CABLEWAYS

Delta-Star Electric Div., H. K. Porter Co. (Delaware)

CAGERS, CAGING EQUIPMENT

C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Robert Holmes & Bros., Inc.

The Nolan Co.
Robert & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CAGES
C. S. Card Iron Works
Connellsville Mfg. & Supply Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Mayo Tunnel & Mine Equipment Co.
The Nolan Co.
Nordberg Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Vulcan Iron Works

CAGES, ELEVATOR-TYPE
Connellsville Mfg. & Mine Supply Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Mayo Tunnel & Mine Equipment Co.

CALCIUM CHLORIDE
Columbia-Southern Chemical Corp.
The Dow Chemical Co.—"DOWFLAKE," "PELADOW"
E. I. du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Fuel Process Co.
Solvay Process Div., Allied Chemical & Dye Corp.
Wyandotte Chemicals Corp., Michigan Alkali Div.

CANVAS
Bemis Bro. Bag Co.

CAPACITORS
Cornell-Dubilier Electric Corp.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Westinghouse Electric Corp.

CAP-LAMP CHARGERS
Mine Safety Appliances Co.
National Mine Service Co.

CAP-LAMP RACKS
Mine Safety Appliances Co.
National Mine Service Co.

CAP LAMPS
Mine Safety Appliances Co.—"EDISON R4"
National Mine Service Co.

CAR BY-PASSERS
American Mine Door Co.—"CANTON"

CAR DUMPERS
Link-Belt Co., Dept. CAMGL-57

CAR DUMPERS, R. R. ROTARY
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Heyl & Patterson, Inc.
Link-Belt Co. Dept. CAMGL-57—"LINK-BELT"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Vulcan Iron Works
Wellman Engineering Co., McDowell Enterprise

CAR HAULS, MINE
Link-Belt Co., Dept. CAMGL-57
Nolan Co.

CAR HAULS, MOVERS, PULLERS, R. R.
Aldon Co.
Advance Car Mover Co., Inc.—"BADGER," "NEW BADGER," "POWER KING," "POWER BOY"
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co. Dept. CAMGL-57—"LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webster Mfg. Inc.
Whiting Corp.

CAR HAULS, MOVERS, SPOTTERS, MINE
Aldon Co.
Connellsville Mfg. & Mine Supply Co.
Fairmont Machinery Co.
Flood City Brass & Electric Co.
Gibraltar Equipment & Mfg. Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT"
Morse Bros. Machinery Co.
B. J. Nykerk Corp.—"HAUSHERR"
Sanford Day Iron Works, Inc.
Schroeder Brothers Corp.
W. R. Stamler Corp.—"STAMLER"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webster Mfg. Inc.
Wilmot Engineering Co.

CAR HOLDS, STOPS, MINE
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Duquesne Mine Supply Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
The Nolan Co.

CAR PASSERS
Mayo Tunnel & Mine Equipment Co.

CAR PULLERS
Clyde Iron Works, Inc.

CAR PULLERS, R. R.
American Engineering Co.—"LO-HED"

CAR RETARDERS, MINE CAR
Connellsville Mfg. & Mine Supply Co.
Fairmont Machinery Co.
Guyan Machy. Co.
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57 "LINK-BELT"
The Nolan Co.
B. J. Nykerk Corp.—"HAUSHERR"
Sanford Day Iron Works, Inc.
Webster Mfg. Inc.

CAR RETARDERS, R. R.
Guyan Machy. Co.
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Union Switch & Signal Div. of Westinghouse Air Brake Co.
Webster Mfg. Inc.

CAR SHAKERS, R. R.
Allis-Chalmers Mfg Co., Industrial Equipment Div.
Hewitt-Robins Incorporated
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT"
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.—"CARQUAKE"
Webster Mfg. Inc.

CAR SPOTTERS
Link-Belt Co., Dept. CAMGL-57
Nolan Co.—"PORTA-FEEDER"

CAR STOPS
Gibraltar Equipment & Mfg. Co.
Nolan Co.

CAR STOPS, ELECTRIC
Cheatham Elec. Switching Device Co.

CAR THAWERS
Hauck Mfg. Co.

CAR TRANSFERS, MINE
American Mine Door Co.—"CANTON"
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.

CARS, RAIL, MAN-TRIP, SELF-PROPELLED
Lee-Norse Co.—"MINE PORTAL BUS"

CARS, SHUTTLE, REPAIRS
Leman Machine Co.

CARBIDE METALS, SINTERED
Allegheny Ludlum Steel Corp.

CARBON BLACK
Fisher Scientific Co.
R. T. Vanderbilt Co. Inc.

CARRIERS, MINE EQUIPMENT
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Leman Machine Co.

CARRIERS, SHUTTLE-CAR
Salem-Brosius, Inc.—"PHILDOLLY"

CARS, BALLAST
Differential Steel Car Co.

CARS, RAIL, AIR-DUMP
C. S. Card Iron Works
Differential Steel Car Co.

CARS, RAIL, MAN TRIP
Bethlehem Steel Co.
C. S. Card Iron Works
Differential Steel Car Co
Enterprise Wheel & Car Corp.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.—"MANVAN"
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, RAIL, MINE
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kersey Manufacturing Co., Inc.
Mayo Tunnel & Mine Equipment Co.
Morse Bros. Machinery Co.
Sanford Day Iron Works, Inc.
U. S. Steel Corp.
Watt Car & Wheel Co.

CARS, RAIL, PERSONNEL, SELF-PROPELLED
Irwin Foundry & Mine Car Co.
Lee-Norse Co.—"MINE JITNEY & SCOOTER"

CARS, RAIL, SUPPLY
Bethlehem Steel Co.
C. S. Card Iron Works
Differential Steel Car Co.
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Mayo Tunnel & Mine Equipment Co.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

CARS, RAIL, TOOL & REPAIR, SELF-PROPELLED
Joy Mfg. Co.

CARS, RUBBER-TIRED, COAL, SELF PROPELLED
Joy Mfg. Co.
Prime Mover Co. — "M30 PRIME MOVER"

CARS, RUBBER-TIRED, MEN & SUPPLIES, SELF-PROPELLED
Joy Mfg. Co.
Kanawha Mfg. Co.
Lee-Norse Co. — "UTILITY TRUCK"
Prime Mover Co. — "M30 PRIME MOVER"

CARS, RUBBER-TIRED TRAILING, COAL
Goodman Mfg. Co.
Joy Mfg. Co.
Kersey Manufacturing Co., Inc.

CARS, RUBBER-TIRED TRAILING, MEN & SUPPLIES
Kersey Manufacturing Co., Inc.

CARS, SHUTTLE
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.
National Mine Service Co.—"TOR KAR"

CARS, SHUTTLE, CRAWLER-TYPE
Myers-Whaley Co.—"WHALEY TRANSFER CAR"

CARS, SHUTTLE, DIESEL
Joy Mfg. Co.

CARS, SURGE
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Joy Mfg. Co.

CARTRIDGES, CYLINDERICAL AND FLANGE BALL-BEARING
Bearings, Inc.
Link-Belt Co., Dept. CAMGL-57

CASTINGS, ALLOY
Coast Metals, Inc.

CASTINGS, ABRASION-RESISTANT
Wall Colmonoy Corp.

CASTINGS, BRONZE
American Brake Shoe Co., National Bearing Div.

CASTINGS, GRAY IRON
Link Belt Co., Dept. CAMGL-57

CASTINGS, HEAT-, CORROSION- & ABRASION-RESISTANT
Electric Steel Foundry Co.

CASTINGS, IRON, MEEHANITE, MODULAR AND STEEL
Farrel-Birmingham Co., Inc.

CASTINGS, MALLEABLE IRON
Link-Belt Co., Dept. CAMGL-57

CASTINGS, MANGANESE STEEL
Kensington Steel, Div. of Poor & Co.

CASTINGS STAINLESS STEEL
Fischer & Porter Co.

CASTINGS STEEL
Falk Corp. — "MOLY-TELASTIC"

CAUSTIC SODA
American Minechem Co.
Columbia-Southern Chemical Corp.
The Dow Chemical Co.
E. I du Pont de Nemours & Co., Inc.
Fisher Scientific Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

CEMENT, HIGH-TEMPERATURE
Babcock & Wilcox Co.
Philip Carey Mfg. Co.—"MW-50," "MW-ONE"
Joseph Dixon Crucible Co.
Johns-Manville—"Blakite"
Mexico Refractories Co.—"BONDSET," "HILOSET," "HY-SET"
Norton Co.—"ALUNDUM," "CRYSTOLON"

CENTRIFUGES
Heyl & Patterson, Inc.—"REINEVELD"

CHAIN, CONVEYOR & ELEVATOR
American Brake Shoe Co., Amsco Div.—"AMSCO"
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
Diamond Chain Co., Inc.
J. D. Christian Engineers
Continental Gin Co.
The Daniels Co., Contractors, Inc.
Herold Mfg. Co.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel, Div., of Poor & Co.
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT"
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Ore Reclamation Co.
K. Prins & Associates
Republic Steel Corp.—"REPUBLIC"
W. J. Savage Co.
Taylor-Wharton Co. Div. Harsco Corp.
Transall Inc.
Watt Car & Wheel Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CHAIN, FLIGHT CONVEYOR & ELEVATOR
Whitney Chain Co.

CHAIN POWER-TRANSMISSION
Bonded Scale & Machine Co.
Browning Mfg. Co.
Chain Belt Co—"REX"
J. D. Christian Engineers
Continental Gin Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
Jeffrey Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Mining Machine Parts, Inc.
Morse Chain Co., A Borg-Warner Industry
Transall Inc.
Whitney Chain Co.

CHAIN REPAIR LINKS
Page Engineering Co.—"TWIN-PIN"

CHAIN, ROLLER
Flood City Brass & Electric Co.

CHAIN, SHUTTLE CAR
Whitney Chain Co.

CHAIN, WELDED
American Chain & Cable Co., Inc., American Chain Div.
Page Engineering Co.
Republic Steel Corp.

CHAIN FITTINGS
American Chain & Cable Co., Inc., American Chain Div.
Crosby Laughlin Div., American Hoist & Derrick Co., "CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Page Engineering Co.
Republic Steel Corp.—"REPUBLIC"
Taylor-Wharton Co. Div., Harsco Corp.

CHAIRS, CAGE-LANDING
Nolan Co.

CHUTES
American Brake Shoe Co., Amsco Div.—"AMSCO"
The Daniels Co., Contractors, Inc.
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
L. O. Koven & Bro., Inc.
Link-Belt Co., Dept. CAMGL-57
Lippman Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Thomas Engineering & Construction Co.
Transall Inc.
Wilmot Engineering Co.

CHUTES, DIVERSION, COAL LOADING
The Daniels Co., Contractors, Inc.
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Schroeder Brothers Corp.
Thomas Engineering & Construction Co.
Wilmot Engineering Co.

CIRCUIT BREAKERS
Cutler-Hammer, Inc.—"UNIT"

CIRCUIT BREAKERS, AIR
Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"RUPTAIR"
Crouse-Hinds Co.
Dooley Brothers
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Heinemann Electric Co. — "MAGNETTE," "AERO-MAGNETTE," "RE-CIRK-IT," "RE-CIRK-IT-MAG-NETTE"
Joy Mfg. Co.
National Mine Service Co.
Square D Co.
Westinghouse Electric Corp.

CIRCUIT BREAKERS, OIL
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Westinghouse Electric Corp.

CIRCUIT BREAKERS, MOLDED-CASE
Circuit Protective Devices Dept., General Electric Co.
Square D Co.

CIRCUIT, INTERRUPTORS, TRAILING CABLE
Joy Mfg. Co.
Ohio Brass Co.—"MAGNA-TRIP"

CIRCULATING OIL SYSTEMS
Farval Corp.

CLAMPS
B. F. Goodrich Industrial Products Co.—"PUNCHLOK"

CLAMPS, FUSE
Bussmann Mfg. Co.
Holub Industries, Inc.

CLAMPS, FUSE & TEST
Circuit Protective Devices Dept., General Electric Co.
Graybar Elec. Co., Inc.
Ideal Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"KLIPLOK"

CLAMSHELLS
Electric Steel Foundry Co.
Koehring Co.
Marion Power Shovel Co.
Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.
Wellman Engineering Co., McDowell Enterprise

CLARIFIERS, EFFLUENT, WASTE WATER

Bulkley, Dunton Processes, Inc.
Link-Belt Co., Dept. CAMGL-57

CLASSIFIERS, HYDRAULIC

Bird Machine Co.
Nelson L. Davis Co.—"NELDCO"
Deister Concentrator Co.—"CONCENCO"
Deister Machine Co.
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Link-Belt Co., Dept. CAMGL-57
Peterson Filters & Engineering Co.
Smith Engineering Works
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.—"HYDROTATOR"
Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

CLASSIFIERS, MECHANICAL

Colorado Iron Works Co., A Sub. of Mine & Smelter Supply Co.—"AKINS"
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Eagle Iron Works
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-57
Morse Bros. Machinery Co.—"TRUELINE"
Straub Mfg. Co., Inc.
Western Machinery Co.—"WEMCO"

CLEANERS, STEAM

Homestead Valve Mfg. Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

CLEANERS, ULTRASONIC

General Nuclear Corp.

CLEANING COMPOUNDS, STEAM CLEANING

Homestead Valve Mfg. Co.

CLOTH, ELECTRIC INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

CLOTHING, PROTECTIVE

B. F. Goodrich Industrial Products Co.
Pulmosan Safety Equip. Co.

CLUTCH FACINGS

Raybestos Manhattan, Inc., Manhattan Rubber Div.
S. K. Wellman Co.—"VELVETOUCH FERAMIC," "VELVETOUCH CERAMIC"

CLUTCHES, AIR

Dodge Mfg. Corp.—"AIR-GRIP"

CLUTCHES, AUTOMATIC

Centric Clutch Co.
Hewitt-Robins Incorporated
Marland One-Way Clutch Co.
Twin Disc Clutch Co.

CLUTCHES, ELECTRIC

I-T-E Circuit Breaker Co.

CLUTCHES, FRICTION

Centric Clutch Co.
Dodge Mfg. Corp—"DIAMOND D," "ROLLING GRIP"
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Morse Chain Co., A Borg-Warner Industry—"TORQUE LIMITERS"
Twin Disc Clutch Co.

CLUTCHES, HYDRAULIC

American Blower, Div. of American-Standard

CLUTCHES, JAW

Link-Belt Co., Dept. CAMGL-57

CLUTCHES, MAGNETIC

Cutler-Hammer, Inc. — "C-H Type DL"
Dynamic Div., Eaton Mfg. Co.

CLUTCHES, OVERRUNNING

Centric Clutch Co.
Marland One-Way Clutch Co.
Morse Chain Co., A Borg-Warner Industry—"CAM CLUTCHES"
Joy Mfg. Co.

COAL ANALYSIS LABORATORIES

Commercial Testing & Engineering Co.
Robert Holmes & Bros., Inc.
Manu-Mine Research & Development Co.
Warner Laboratories

COAL BREAKERS, AIR

Cardox Corp.
Le Roi Div., Westinghouse Air Brake Co.—"ARMSTRONG"
Olin-Mathieson Chemical Corp., Explosives Div.—"ARMSTRONG"

COAL BREAKERS, CO_2

Cardox Corp.

COAL BREAKERS, CHEMICAL

Cardox Corp.

COAL INSPECTION

Commercial Testing & Engineering Co.

COAL SAMPLING

Commercial Testing & Engineering Co.

COATINGS, BUILDING ROOFS

Philip Carey Mfg. Co.
Johns-Manville — "ASBESILE," "AQUADAM," "REGAL"
Pittsburgh Plate Glass Co. — "PITTSBURGH"
Ruberoid Co.
Stonhard Co. Inc.
Warren Refining & Chemical Co.—"STORM KING," "STORM KING PLUS," "STORM KING ALUMINUM"

COATINGS, CAST PIPE

Goodyear Tire & Rubber Co., Industrial Prods. Div.
Stonhard Co. Inc.

COATINGS, LIQUID STAINLESS-STEEL

Slip-On, Inc.

COATINGS, MINE ROOF, RIBS

American Minechem Co.—"ROOFSKIN"
Stonhard Co. Inc.

COATINGS, PERMANENT STOPPINGS

American Minechem Co.—"STOPPERSKIN"
Stonhard Co. Inc.

COATINGS, PROTECTIVE, RUST-PREVENTIVE

American Minechem Co.
Ashland Oil & Refining Co.—"ASHLAND TECTYL"
Philip Carey Mfg. Co.
Cities Service Oil Co.
Joseph Dixon Crucible Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Esso Standard Oil Co.—"RUST-BAN"
B. F. Goodrich Chemical Co.—"GEON"
Insul-Mastic Corp. of America—"INSUL-MASTIC VAPOR-SEAL"
Johns-Manville — "INSUL-KOTE"
Keystone Lubricating Co.
Magic Chemical Co.—"MAGIC-VULC"
Master Bronze Powder Co., Inc.—"DERUSTO"
Osmose Wood Preserving Co.
Pittsburgh Plate Glass Co.—"PITTSBURGH"
Ruberoid Co.
Rust-Oleum Corp.
Shell Oil Co.
Sika Chemical Corp.—"SIKA-SEAL"
Standard Oil Co. (Ind.)
Stonhard Co., Inc.—"STON-COTE"
United States Rubber Co.
Valvoline Oil Co., Div Ashland Oil & Refining Co.
Warren Refining & Chemical Co.—"WARCO"
Wilbur & Williams Co.—"TOT-RUST"

COATINGS, R. R.-CAR

American Minechem Co.—"HOPPERCOAT"

COATINGS, REFRACTORY

Mexico Refractories Co.—"MEXICAN," "SPRAY MIX" "SUPER MASTIC," "HELSPOT LADLE WASH," "HEKSKOTE"

COATINGS, WATER SEALING

Philip Carey Mfg. Co.
Insul-Mastic Corp. of America—"INSUL-MASTIC VAPOR-SEAL"
Johns-Manville—"INSUL-KOTE"
Manu-Mine Research & Development Co.
Osmose Wood Preserving Co.
Rust-Oleum Corp.
Sika Chemical Corp.
Stonhard Co., Inc.—"STON-TITE"

COIL TESTERS

Flood City Brass & Electric Co.
Martindale Electric Co.

COILS, ARMATURE, FIELD, ETC.

Flood City Brass & Electric Co.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Jeffrey Mfg. Co.
National Electric Coil Co.
Pennsylvania Electric Coil Corp.
West Virginia Armature Co.
Westinghouse Electric Corp.

COILS, DEMAGNETIZING

Dings Magnetic Separator Co.

COLLIMATORS, VERTICAL

Kern Instruments, Inc.

COMBUSTION, CONTROL SYSTEMS

Canton Stoker Corp.—"FLO-TUBE"

COMMUNICATIONS, CARRIER-CURRENT

Femco, Inc.—"TROLLEY-PHONE," "ADALINE," "CAGEPHONE"
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Industrial Physics & Electronics Co.
Mine Safety Appliances Co.—"MINEPHONE," "HOISTPHONE"
Talk-A-Phone
Union Switch & Signal Div. of Westinghouse Air Brake Co.
Westinghouse Electric Corp.

COMMUNICATORS, INTEROFFICE & PLANT

Femco, Inc.
Graybar Elec. Co., Inc.
Industrial Physics & Electronics Co.
Talk-A-Phone
Wheeler Insulated Wire Co., Inc., Div. Sperry Rand Corp.

COMMUTATOR TOOLS

Holub Industries, Inc.
Ideal Industries, Inc.
Martindale Electric Co.
Ohio Carbon Co.
Snap-on Tools Corp.
West Virginia Armature Co.

COMMUTATORS

Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
West Virginia Armature Co.

COMPOUNDS, COAL-TREATING

American Minechem Co.
Cities Service Oil Co.
Columbia-Southern Chemical Corp.
B. F. Goodrich Chemical Co.—"GOOD-RITE"
Shell Oil Co.
Valvoline Oil Co., Div. Ashland Oil & Refining Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

COMPOUNDS, DEGREASING

American Minechem Co.
Cities Service Oil Co.
Columbia-Southern Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.
Johns-Manville — "HY-SORB"
Wyandotte Chemicals Corp., Michigan Alkali Div.

COMPOUNDS, GENERAL CLEANING

American Minechem Co.
Martindale Electric Co.
Wyandotte Chemicals Corp., Michigan Alkali Div.

COMPOUNDS, INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

COMPOUNDS, PIPE-JOINT

Samuel Cabot, Inc.—"PLASGON"
Philip Carey Mfg. Co.—"SEWERITE"
Joseph Dixon Crucible Co.
Esso Standard Oil Co.
The Garlock Packing Co.
Jet-Lube, Inc.—"KOPP-KOTE," "THICK OR THIN"
Keystone Lubricating Co.—"VIKE GRAPHITE PLASTIC SEAL," "VIKE WATERSEAL"
Sika Chemical Corp.—"IGAS"

COMPOUNDS, SPRAY-WATER ADDITIVE

American Minechem Co.
The Dow Chemical Co.—"SEPARAN 2610"
Johnson-March Corp.—"COMPOUND MR"

CONCRETE FLOOR HARDENERS

Stonhard Co., Inc.—"STONTOP"

CONCRETE MIXERS

Koehring Co.

CONCRETE REINFORCING BARS

West Virginia Works.
Conners Steel Div.

CONCRETE-SPRAYING

Cement Gun Co., Inc.—"GUNITE"
Manu-Mine Research & Development Co.

CONCRETE SPRAYING EQUIPMENT

Cement Gun Co., Inc.—"CEMENT GUNS"
Manu-Mine Research & Development Co.

CONDUIT, ELECTRICAL

Flexaust Co.—"PLICA"
Distribution Assemblies Dept. General Electric Co.
Graybar Elec. Co., Inc.
Johns-Manville — "TRANSITE," "KORDUCT"
Mosebach Electric & Supply Co.
National Electric Products Co.
Republic Steel Corp.—"ELECTRUNITE"
Rome Cable Corp.
Triangle Conduit & Cable Co., Inc.
Youngstown Sheet & Tube Co.—"BUCKEYE"

CONDUIT, ELECTRICAL, ALUMINUM

Reynolds Metals Co.

CONDUIT, ELECTRICAL, PLASTIC

Irvington Div., Minnesota Mining & Mfg. Co.

CONDUIT FITTINGS

Crouse-Hinds Co.—"CONDULET"
Graybar Elec. Co., Inc.
Ideal Industries, Inc.
National Electric Products Co.
Rome Cable Corp.
Triangle Conduit & Cable Co. Inc.
Youngstown Sheet & Tube Co.

CONNECTING WIRE

Hercules Powder Co.

CONNECTORS, WIRE

American Cyanamid Co., Explosives Dept.
Burndy Corp., — "HYLUGS" "HYLINKS"
Circuit Protective Devices Dept., General Electric Co.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Graybar Elec. Co., Inc.
Holub Industries, Inc.
Ideal Industries, Inc.—"WIRE-NUTS"
Lincoln Electric Co.—"Q-D"
National Electric Products Co.
R. W. Nichols Co.—"DEUTSCH"
Ohio Brass Co.
Schroeder Brothers Corp.

CONSULTANTS, OPERATIONS & MANAGEMENT

Eavenson, Auchmuty & Greenwald

CONTACTORS, ELECTRICAL

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co.
Cutler-Hammer, Inc.
Dooley Brothers
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Jeffrey Mfg. Co
Joy Mfg. Co.
Ohio Carbon Co.
Schroeder Brothers Corp.
Speer Carbon Co.
Square D Co.
Bertrand P. Tracy Co.
Westinghouse Electric Corp.

CONTACTS, CARBON

Keystone Carbon Co.

CONTACTS, METAL-GRAPHITE

Keystone Carbon Co.

CONTAINERS, RUBBER COLLAPSIBLE

United States Rubber Co.

CONTINUOUS MINERS

Compton, Inc.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Lee-Norse Co.—"LEE NORSE MINER"
National Mine Service Co., Clarkson Div. — "MARIETTA"
Wilcox Mfg. Co.—"WILCOX MINER"

CONTINUOUS MINERS, REPAIRS

Leman Machine Co.

CONTRACTORS, BUILDING, ERECTING

Arrowhead Steel Buildings, Inc.
Dravo Corp.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Thomas Engineering & Construction Co.
Vincennes Steel Corp.

CONTRACTORS, DRILLING

Hoffman Bros. Drilling and Mfg. Co.
Joy Mfg. Co.
E. J. Longyear Co.
Manu-Mine Research & Development Co.
Mobile Drilling Inc.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood

CONTRACTORS, ELECTRICAL-CONSTRUCTION

The Daniels Co., Contractors, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CONTRACTORS, GROUTING

Cowin & Co., Inc.
Hoffman Bros. Drilling and Mfg. Co.
E. J. Longyear Co.
Manu-Mine Research & Development Co.
Mobile Drilling Inc.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sprague & Henwood

CONTRACTORS, SHAFT-DRILLING

Cowin & Co., Inc.
Pennsylvania Drilling Co.

CONTRACTORS, SHAFT & SLOPE

Cowin & Co., Inc.
R. G. Johnson Co.
Manu-Mine Research & Development Co.

CONTRACTORS, SOIL SAMPLING

E. J. Longyear Co.

CONTROL CENTERS, ELECTRICAL

Distribution Assemblies Dept., General Electric Co.

CONTROLLERS, ELECTRIC, & PARTS

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Bristol Co.—"BRISTOL'S"
Clark Controller Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
Fischer & Porter Co.
Flood City Brass & Electric Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Hays Corp.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Schroeder Brothers Corp.
Square D Co.
Bertrand P. Tracy Co.
Westinghouse Electric Corp.

CONTROLLERS, ELECTRIC TRACK-SWITCH & DERAIL

Cheatham Elec. Switching Device Co.

CONTROLLERS, ELECTRONIC

The Bristol Co. — "FREE-VANE"
A. W. Cash Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Femco, Inc.
Fischer & Porter Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
Hays Corp.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Division—"ELECTR - O - PULSE," "ELECTR - O - LINE," "ELECTR - O - VANE"
Reliance Elec. & Eng. Co.
Square D Co.

CONTROLLERS, HYDRAULIC

The Bristol Co.—"BRISTOL'S"
Industrial Physics & Electronics Co.
Joy Mfg. Co.
Schroeder Brothers Corp.
Vickers Inc.

CONTROLLERS, LOCOMOTIVE

General Electric Co., Apparatus Sales Div.

Ironton Engine Co. — "IRONTON"
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.

CONTROLLERS, PNEUMATIC
B-I-F Industries, Inc.
The Bristol Co.—"FREEVANE"
A. W. Cash Co.
Farris Flexible Valve Corp. — "FLEX-VALVE"
Fischer & Porter Co.—PNEUMATROL"
Foxboro Co.
Industrial Physics & Electronics Co.
Joy Mfg. Co.
Minneapolis-Honeywell Regulator Co., Industrial Division—"AIR-O-LINE"

CONTROLS, CABLE OPERATED
Woolridge Mfg. Div., Continental Copper & Steel Industries, Inc.

CONTROLLERS, TEMPERATURE
West Instrument Corp. "GUARDSMEN"

CONTROLS, INDUCTIVE-CARRIER, REMOTE
The Bristol Co. — "METAMETER TELEMETER"
Femco, Inc.
Graybar Elec. Co., Inc.
Industrial Physics & Electronics Co.
Union Switch & Signal Div. of Westinghouse Air Brake Co.
Westinghouse Electric Corp.

CONVEYOR-BELT DRIVE PULLEYS
The American Pulley Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Dodge Mfg. Corp. — "TAPER-LOCK"
Hewitt-Robins Incorporated
Homer Mfg. Co., Inc. — "HOMER MAGNETIC"
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
W. J. Savage Co.
Transall Inc.
Webster Mfg. Inc.
W. Va. Belt & Cable Repairs, Inc.
T. B. Woods Sons Co.

CONVEYOR-BELT IDLER PULLEYS
The American Pulley Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Galigher Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
W. J. Savage Co.
Transall Inc.
Webster Mfg. Inc.
T. B. Woods Sons Co.

CONVEYOR-BELT IDLERS
Barber-Greene Co.
Bonded Scale & Machine Co.—"BONDED," "TRAINING"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Galigher Co.
Goodyear Tire & Rubber Co.—"PNEUMATIC"
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co. — "LIMBEROLLER"
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57 — "SERIES 100, 200," "LINK-BELT"
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co. — "AUTO-TILT," "MAMOTH," "SIMPLEX," "SACON," "SUPER SIMPLEX," "JUNIOR SIMPLEX," "PACIFIC"
Transall Inc.
Webster Mfg. Inc.

CONVEYOR-BELT LOADING STATIONS, AUTOMATIC MINE
Link-Belt., Dept. CAMGL-57
W. R. Stamler Corp.

CONVEYOR-BELT REPAIR KITS
Magic Chemical Co.

CONVEYOR BELT TRIPPERS
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Hewitt-Robins, Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Quaker Rubber Div, H. K. Porter Co., Inc.
Stephens-Adamson Mfg Co.
Transall, Inc.
Webster Mfg. Inc.

CONVEYOR BELTING
Barber-Greene Co.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div. —"WISSCO"
Continental Gin Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"CARICOAL"
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.—"KING KOAL," "PYRO PRENE"
Hewitt-Robins Incorporated—"AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAYNILE"
Industrial Rubber Products Co. (Pa.)
Iowa Mfg. Co.
Joy Mfg Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57
National Mine Service Co.
New York Belting & Packing Co.—"GREAT SEAL," "INDESTRUCTIBLE," "CLIFTON," "NYTEX NYLON," "PARALIFT"
Pioneer Engineering, Div. of Poor & Co.
Quaker Rubber Div., H. K. Porter Co., Inc.—"QUAKER," "QUAKER PIONEER"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"RECORDMAKER"
W. J. Savage Co.
Scandinavia Belting Co.—"SCANDURA"
Smith Engineering Works
Thermoid Co., Industrial Div.
Transall Inc.
United States Rubber Co.
W. Va. Belt & Cable Repairs, Inc.—"NEW YORK RUBBER"

CONVEYOR-BELTING CLEANERS
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Nelson L. Davis Co.—"NELDCO"
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Stephens-Adamson Mfg. Co.
Transall, Inc.
United States Rubber Co.

CONVEYOR-BELTING FASTENERS
Armstrong, Bray & Co.—"PLATEGRIP," "HINGED PLATEGRIP"
Bonded Scale & Machine Co.
Carlyle Rubber Co., Inc.
Continental Gin Co.
Crescent Belt Fastener Co. Inc.
Flexible Steel Lacing Co.
General Splice Corp.—"MINET"
Goodyear Tire & Rubber Co.
Industrial Rubber Products Co. (Pa.)
Joy Mfg. Co.
Kremser & Sons, Inc., Frank A.
National Mine Service Co.
Pioneer Engineering, Div. of Poor & Co.
Talcott, Inc.
Transall Inc.
United States Rubber Co.

CONVEYOR-BELTING REPAIR
Armstrong, Bray & Co.—"PLATEGRIP," "HINGED PLATEGRIP"
Carlyle Rubber Co., Inc.
General Splice Corp.
B. F. Goodrich Industrial Products Co.
Industrial Rubber Products Co. (Pa.)
Industrial Rubber Products Co. (W. Va.)
Linatex Corp. of America
Quaker Rubber Div., H. K. Porter Co., Inc.
Reid Belt & Rubber Co. Inc.
United States Rubber Co.
W. Va. Belt & Cable Repairs, Inc.

CONVEYOR-BELTING SPLICING MATERIALS
Armstrong, Bray & Co.—"PLATEGRIP," "HINGED PLATEGRIP"
B. F. Goodrich Industrial Products Co.
General Splice Corp.—"MINET"
Goodyear Tire & Rubber Co.
Industrial Rubber Products Co. (Pa.)
Joy Mfg. Co.
New York Belting & Packing Co.—"N Y B & P"
Pioneer Engineering, Div. of Poor & Co.
Quaker Rubber Div., H. K. Porter Co., Inc.

CONVEYOR-BELTING VULCANIZERS
B. F. Goodrich Industrial Products Co.
Heintz Mfg. Co.
Quaker Rubber Div., H. K. Porter Co., Inc.

CONVEYOR COVERS

Armco Drainage & Metal Prod., Inc.
Arrowhead Steel Buildings, Inc.
Barber-Greene Co.
Continental Gin Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Transall Inc.

CONVEYOR LOADING CHECKS

The Daly Ticket Co.—"DALY"
Quaker Rubber Div., H. K. Porter Co., Inc.

CONVEYOR WEIGHERS

B-I-F Industries, Inc.—"CONVEYELO"
Continental Gin Co.
Femco, Inc.
Industrial Physics & Electronics Co.
Merrick Scale Mfg. Co.—"WEIGHTOMETER"

CONVEYORS, APRON

Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
B. F. Goodrich Industrial Products Co.
Gruendler Crusher & Pulverizer Co.
Harold Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. Engrg. Corp.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"AMSCO"
Webster Mfg. Inc.

CONVEYORS, APRON, REPAIRS

Leman Machine Co.

CONVEYORS, BELT

American Conveyor Co.—"CONVAY-IT," "STOKER-VEYOR"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. "LIMA," "AUSTIN WESTERN"
Barber-Greene Co.
Baughman Mfg. Co., Inc.—"HI-SPEED"
Bonded Scale & Machine Co.—"BONDED"
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WISSCO"
Compton, Inc.
Continental Gin Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
B. F. Goodrich Industrial Products Co.—"CARICOAL"
Gruendler Crusher & Pulverizer Co.
Herold Mfg. Co.
Hewitt-Robins Incorporated — "AJAX," "MALTESE CROSS," "MONARCH," "SUPER RAYNILE"
Heyl & Patterson, Inc.
Homer Mfg. Co., Inc.—"HOMER"
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.—"LIMBEROPE"
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57—"LINK BELT"
Lippmann Engrg. Works Inc.
E. F. Marsh Engrg. Co.—"MARCO"
Meckum Engr. Co.
Morse Bros. Machinery Co.
New York Belting & Packing Co.—"GREAT SEAL," "INDESTRUCTIBLE," "CLIFTON," "NYBTEX NYLON," "PARA LIFT"
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Quaker Rubber Div., H. K. Porter Co., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"ZIPPER"
Transall Inc.
United States Rubber Co.
Universal Engineering Co.
Universal Road Machinery Co.
Webster Mfg. Inc.

CONVEYORS, BELT, EXTENSIBLE

J. D. Christian Engineers
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated—"MINE-AVEYORS"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57—"PRE-BILT"
E. F. Marsh Engrg. Co.—"MARCO"
Minnesota Mining & Mfg. Co.—"SCOTCHLOKS"
Stephens-Adamson Mfg. Co.
Webster Mfg. Inc.

CONVEYORS, BUCKET

American Brake Shoe Co., Amsco Div.—"AMSCO"
Baughman Mfg. Co., Inc. — "HI-SPEED"
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Fairmont Machinery Co.
Galigher Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Koehring Co.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall Inc.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, CHAIN, SINGLE OR DOUBLE CHAIN & FLIGHT

Herold Mfg. Co.

CONVEYORS, CHAIN, CHAIN & FLIGHT

American Brake Shoe Co., Amsco Div.—"AMSCO"
American Conveyor Co. — "FLIGHTVEYOR"
American Well Works
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Compton, Inc.
Continental Gin Co.
The Daniels Co., Contractors, Inc.
Electric Steel Foundry Co.
Electric Alloys Div, American Brake Shoe Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Helmick Foundry-Machine Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kensington Steel, Div of Poor & Co.
Link-Belt Co., Dept. CAMGL-57
The Long Co.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
National Mine Service Co., Clarkson Div.—"REDBIRD," "UNIFLIGHT"
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Transall Inc.
Vulcan Iron Works
Watt Car & Wheel Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, ELEVATING

Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Koehring Co.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works Inc.
The Long Co.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
K. Prins & Associates
Roberts & Schafer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co. — "REDLER," "ZIPPER"
Transall Inc.
United States Rubber Co.
Webster Mfg. Inc.
Wilmot Engineering Co.

CONVEYORS, ELEVATING, MINE TRANSFER, CAR LOADING

Bonded Scale & Machine Co.
J. D. Christian Engineers
Fairmont Machinery Co.
Goodman Mfg. Co.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

CONVEYORS, EXTENSIBLE CHAIN

Wilcox Mfg. Co.—"WILCOX"

CONVEYORS, MINE BRIDGE

Goodman Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
The Long Co.—"PIGGYBACK"
E. F. Marsh Engrg. Co.—"MARCO"

CONVEYORS, MOBILE HEAD, CHAIN

The Long Co.

CONVEYORS, OSCILLATING

Link-Belt Co. Dept. CAMGL-57 — "LINK-BELT," "FLEMOUNT," "COILMOUNT," "TORQMOUNT"

CONVEYORS, PNEUMATIC

Convair

CONVEYORS, PORTABLE

American Conveyor Co. — "CON-VAY-IT"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA," "AUSTIN WESTERN"
Barber-Greene Co.
Baughman Mag. Co., Inc.— "HI-SPEED"
Bonded Scale & Machine Co.— "BONDED"
J. D. Christian Engineers
George Haiss Mfg. Co., Div., Pettibone Mulliken Corp.
Herold Mfg. Co.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Joy Mfg. Co.
Lippmann Engrg. Works Inc.
E. R. Marsh Engrg. Co.— "MARCO"
McNally-Pittsburg Mfg Corp.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
Stephens-Adamson Mfg. Co.

CONVEYORS, ROPE & BUTTON

Fairmont Machinery Co.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CONVEYORS, SCREW

Baughman Mfg. Co., Inc.— "HI-SPEED"
Canton Stoker Corp.—"FLO-TUBE"
J. D. Christian Engineers
Continental Gin Co.
Dallas Engineers Inc., Coal-O-Matic Div.
Dayton Automatic Stoker Co.
Fairfield Engineering Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-57 — "QUIK-LINK"
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Webster Mfg. Inc.

CONVEYORS, SELF-LOADING, MINE

Herold Mfg. Co.
Link-Belt Co., Dept. CAMGL-57

CONVEYORS, SHAKING, MINE

Goodman Mfg. Co.
Herold Mfg. Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Vulcan Iron Works

CONVEYORS, SHAKING, VIBRATING

Ajax Flexible Coupling Co., Inc. — "AJAX LO-VEYOR"
Hewitt-Robins Incorporated
Jeffrey Mfg. Co
Lecco Machinery & Engineering —"LECCO VIB"
Link-Belt Co., Dept. CAMGL-57
Stephens-Adamson Mfg. Co.
Syntron Co.—"VIBRA-FLOW"

CONVEYORS, SPIRAL LOWERING

J. D. Christian Engineers
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.
Quaker Rubber Div., H. K. Porter Co., Inc.

CONVEYORS, VIBRATING

Dravo Corp.
Simplicity Engineering Co.

COPYING EQUIPMENT

Charles Bruning Co., Inc.

CORDS, DRILL

Colyer Insulated Wire Co.
Flood City Brass & Electric Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.

CORDS, PORTABLE, ELECTRIC

Collyer Insulated Wire Co.
Cornish Wire Co., Inc.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Okonite Co.
John A. Roebling's Sons Corp., Sub. of Colorado Fuel & Iron Corp.
Rome Cable Corp.

COUPLERS, AUTOMATIC MINE CAR

C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Mayo Tunnel & Mine Equipment Co.
National Malleable & Steel Castings Co.—"WILLISON," "SHARON 10"
Ohio Brass Co.
Rydin Railway Equip. Co.

COUPLERS, MINE-CAR

Utility Mine Equipment Co.

COUPLINGS, AIR-LINE

Acme Machinery Co.
Cleco Div., Reed Roller Bit Co.
C. B. Hunt & Son, Inc. — "QUICK-AS-WINK"
LE-HI Div., Hose Accessories Co.
Lincoln Engrg. Co.
R. W. Nichols Co.—"BRUNING-GRAFTON"
Schroeder Brothers Corp.

COUPLINGS, BELT

Greene, Tweed & Co. — "MORAN"

COUPLINGS, CHAIN

Link-Belt Co., Dept. CAMGL-57—"AC"

COUPLINGS, CLUTCH

Link-Belt Co., Dept. CAMGL-57
Marland One-Way Clutch Co.

COUPLINGS, FIRE HOSE

Fyr-Fyter Div.

COUPLINGS, FLEXIBLE

Farrel-Birmingham Co., Inc.
Link-Belt Co., Dept. CAMGL-57

COUPLINGS, FLEXIBLE-SHAFT

Ajax Flexible Coupling Co., Inc.
American Flexible Coupling Co. — "AMERICAN - AMERI-GEAR"
Browning Mfg. Co.
Chain Belt Co.—"REX"
Chiksan Co.
J. D. Christian Engineers
Continental Gin Co.
Diamond Chain Co., Inc.
Elliott Co.
Falk Corp. — "STEELFLEX," "AIRFLEX"
Flood City Brass & Electric Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Koppers Co., Inc., Metal Products Div. — "FAST'S"
Link-Belt Co., Dept. CAMGL-57 — "RC," "GEARED"
Morse Chain Co., A Borg-Warner Industry — "MORFLEX"
New York Belting & Packing Co.
Philadelphia Gear Works
Thomas Flexible Coupling Co. —"THOMAS"
Webster Mfg. Inc.
Whitney Chain Co.
T. B. Woods Sons Co.

COUPLINGS, FLUID & HYDRAULIC LINES

Aeroquip Corp., Jackson Div.— "SELF SEALING"
Blackhawk Mfg. Co.
Chiksan Co.
C. B. Hunt & Son, Inc. — "QUICK-AS-WINK"
LE-HI Div., Hose Accessories Co.
Link-Belt Co., Dept. CAMGL-57
R. W. Nichols Co. — "BRUNING-GRAFTON"
Weatherhead Co., Fort Wayne Div.

COUPLINGS, GROOVED-END PIPE

Gustin-Bacon Mfg. Co. — "GRUVAGRIP," "GRUVA-JOINT"

COUPLINGS, HOSE

Acme Machinery Co.
Aeroquip Corp., Jackson Div.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Franklin Plastics Inc. — "DUR X PLASTIC"
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Hewitt-Robins Incorporated
C. B. Hunt & Son, Inc. — "QUICK-AS-WINK"
Industrial Rubber Products Co (Pa.)
LE-HI Div., Hose Accessories Co.
Lincoln Engrg. Co. — "LOK-TITE"
Meckum Engr. Co.
New York Belting & Packing Co.
R. W. Nichols Co.—"GRAFTON"
Schroeder Brothers Corp.
Thor Power Tool Co.
United States Rubber Co. — "EVERTITE"
Victor Equipment Co.
Weatherhead Co., Fort Wayne Div.

COUPLINGS, HYDRAULIC-DRIVE

Twin Disc Clutch Co.

COUPLINGS, MAGNETIC-DRIVE

Dynamatic Div., Eaton Mfg. Co.

COUPLINGS SHAFT

Dodge Mfg. Corp. — "PARA-FLUX"

COUPLINGS, SHAFT-FLEXIBLE, RIGID, CHAIN

Dodge Mfg. Corp — "TAPER-LOCK"

COUPLINGS, SWIVEL, BRONZE

The Lunkenheimer Co. — "LUNKENHEIMER"

CRANES, CRAWLER

Link-Belt Speeder Corp.
Quick-Way Truck Shovel Co.

CRANES, GANTRY & WALL

Shepard Niles Crane & Hoist Corp.

CRANES, JIB & BRACKET

Shepard Niles Crane & Hoist Corp.

CRANES, MOBILE

American Hoist & Derrick Co. —"AMERICAN"
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA"
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div. — "MICHIGAN"
Dravo Corp.
Gar Wood Industries, Inc.
Harnischfeger Corp.

Hyster Co. — "KARRY KRANE"
Koehring Co.
LeTourneau-Westinghouse Co. — "TOURNAPULL"
Marion Power Shovel Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Ruger Equipment, Inc. — "RUGER"
Schield Bantam Co.
Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

CRANES, RUBBER-TIRED, SELF-PROPELLED
Link-Belt Speeder Corp.

CRANES, SHOP & PLANT
Austin-Western Works, Construction Equipment Div. Baldwin-Lima-Hamilton Corp.
Guyan Machy. Co.
Harnischfeger Corp.
Koehring Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div. — "SHAW BOX LOAD LIFTER"
Morse Bros. Machinery Co.
Robbins & Meyers, Inc. — "R & M"
Shepard Niles Crane & Hoist Corp.

CRANES, SPECIAL
Welman Engineering Co., McDowell Enterprise

CRANES, TRACTOR
Allis-Chalmers Mfg Co., Construction Machinery Div.

CRANES, TRACTOR & TRUCK
Austin-Western Works, Construction Equipment Div. Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp. Construction Equipment Div. —"LIMA"
Clark Equipment Co., Construction Machinery Div. — "MICHIGAN"
The Four Wheel Drive Auto Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Insley Mfg. Corp.
Marion Power Shovel Co.

CRANES, TRUCK
American Hoist & Derrick Co. —"AMERICAN"
Austin-Western Works, Construction Equipment Div. Baldwin-Lima-Hamilton Corp.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA"
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div. — "MICHIGAN"
The Four Wheel Drive Auto Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Insley Mfg. Corp.
Koehring Co.
Link-Belt Speeder Corp. — "ZEPHYRCRANES"
Marion Power Shovel Co.
Northwest Engineering Co.
The Oster Mfg. Co.
Pitman Manufacturing Co. — "HYDR-A-LIFT"
Quick-Way Truck Shovel Co.
Ruger Equipment, Inc. — "RUGER"
Schield Bantam Co.
Thew Shovel Co. — "LORAIN MOTOCRANE"
Yale & Towne Mfg. Co.

CRANES, TRUCK, CHASSIS
Hendrickson Mfg. Co.

CRANES, WHIRLEY
Clyde Iron Works, Inc.

CRAWLER PADS
American Brake Shoe Co., Amsco Div.—"AMSCO"
Kensington Steel, Div. of Poor & Co.

CREOSOTE OIL
Republic Creosoting Co.

CROSSING SIGNALS, RAIL, HIGHWAY
American Mine Door Co.
Nachod & U. S. Signal Co.

CRUSHER JAWS
American Brake Shoe Co., Amsco Div.—"AMSCO"
Kensington Steel, Div. of Poor & Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.

CRUSHERS, HAMMER
American Pulverizer Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Sprout, Waldron & Co., Inc.
Stedman Foundry & Machine Co., Inc.
Sturtevant Mill Co.
Universal Engineering Co.—"BULLDOG"
Williams Patent Crusher & Pulv. Co.

CRUSHERS, IMPACT
Nordberg Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.

CRUSHERS, JAW
Denver Equipment Co.—"DENVER"
Diamond Iron Works, Div. Goodman Mfg. Co.
Straub Mfg. Co. Inc.—"KUEKEN"
Universal Engineering Co.—"BULLDOG"

CRUSHERS, LABORATORY
American Pulverizer Co.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Stedman Foundry & Machine Co., Inc.
Sturtevant Mill Co.
Universal Engineering Co.
Williams Patent Crusher & Pulv. Co.
Wise Co., O. B.

CRUSHERS, REPLACEMENT PARTS
American Brake Shoe Co., Amsco Div.—"AMSCO"
American Steel Foundries—"WEARPACT"
Electric Steel Foundry Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pioneer Engineering, Div. of Poor & Co.
Stedman Foundry & Machine Co., Inc.
Taylor-Wharton Co. Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Universal Engineering Co.
Williams Patent Crusher & Pulv Co.

CRUSHERS, RING
American Pulverizer Co.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Simplicity Engineering Co.
Stedman Foundry & Machine Co., Inc.
Stephens-Adamson Mfg. Co.—"KNITTEL"
Williams Patent Crusher & Pulv. Co.

CRUSHERS, ROLL
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA," "AUSTIN WESTERN"
Bonded Scale & Machine Co.—"BONDED"
Denver Equipment Co.—"DENVER"
Diamond Iron Works, Div. Goodman Mfg. Co.
Eagle Iron Works
Gruendler Crusher & Pulverizer Co.
T. J. Gundlach Machine Co.—"GUNDLACH"
Guyan Machy. Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-57
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Pioneer Engineering, Div. of Poor & Co.
Stedman Foundry & Machine Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Traylor Engineering & Mfg. Co.
Universal Engineering Co.
Webster Mfg. Inc.
Williams Patent Crusher & Pulv. Co.
Wilmot Engineering Co.

CRUSHERS, SAMPLE
American Pulverizer Co.
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Stedman Foundry & Machine Co., Inc.
Sturtevant Mill Co.
Williams Patent Crusher & Pulv. Co.

CRUSHERS, TRIPLE-ROLL
McLanahan & Stone Corp.

CRUSHERS, TWO-STAGE
Gruendler Crusher & Pulverizer Co.
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc. —"GUNDLACH"
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Pennsylvania Crusher Div., Bath Iron Works Corp.
Stedman Foundry & Machine Co., Inc.
Universal Engineering Co. "TWINDUAL"
Williams Patent Crusher & Pulv. Co.

CRUSHING ROLLS, LABORATORY
Colorado Iron Works Co., A Sub. of Mine & Smelter Supply Co.

CULVERTS, CORRUGATED-METAL
Armco Drainage & Metal Prod., Inc.

CUPS, GREASE AND OIL
Link-Belt Co., Dept. CAMGL-57
The Lunkenheimer Co.—"ALSEN," "GEM," "PIONEER," "ROYAL," "SENTINEL," "TIGER"

CUT-OFF WHEELS, ABRASIVE
Allison Div., American Chain & Cable Co., Inc.

CUT-OUTS-ELECTRICAL
Duquesne Mine Supply Co.

General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.

CUT-OUTS, OIL FUSE
G & W Electric Specialty Co.

CUTTER BARS
Bowdil Co.
Cincinnati Mine Machinery Co. —"CINCINNATI"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Penn Machine Co.
Frank Prox Company Inc.
Bertrand P. Tracy Co.

CUTTER BARS, REBUILDING
Leman Machine Co.

CUTTER CHAINS
Bowdil Co.
Cincinnati Mine Machinery Co.—"CINCINNATI"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Marathon Coal Bit Co. Inc.—"TRACY"
Penn Machine Co.
Frank Prox Company, Inc.
Bertrand P. Tracy Co.

CUTTERS, BAR, CABLE, CHAIN, ROD, WIRE ROPE, ETC.
H. K. Porter, Inc.

CUTTERS, PIPE
Beaver Pipe Tools, Inc.

CUTTING MACHINES
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Morse Bros. Machinery Co.

CUTTING MACHINES, REBUILT
Leman Machine Co.

CUTTING TORCHES—See Welding Torches

CUTTINGS MACHINES, CONVERTED TRACK TO RUBBER
Lee-Norse Co.
Leman Machine Co.

CYCLONES, AIR TREATMENT
Combustion Engineering, Inc., Raymond Div.
The Ducon Co. Inc.
Hardinge Co., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Western Precipitation Corp.—"MULTICLONE"

CYCLONES, WATER TREATMENT
Bird Machine Co.
Centrifugal & Mech. Industries, Inc. "CLUST-R-CLONE"
The Daniels Co., Contractors, Inc.
Dorr-Oliver, Inc.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
McNally-Pittsburg Mfg. Corp.
Peterson Filters & Engineering Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

CYLINDERS, AIR
Ledeen Mfg. Co.
R. W. Nichols Co.—"ALKON"
Schroeder Brothers Corp.
Wellman Engineering Co., McDowell Enterprise

CYLINDERS, DOOR OPERATORS
Ledeen Mfg. Co

CYLINDERS, DUMP GATE OPERATORS
Ledeen Mfg. Co.

DEMAGNETIZERS
Martindale Electric Co.

DERAILERS
American Mine Door Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Miners' Hardware Supply Co.
The Nolan Co.
Sanford Day Iron Works, Inc.

DERAILERS, ELECTRIC, AUTOMATIC & REMOTELY CONTROLLED
American Mine Door Co.
Cheatham Elec. Switching Device Co.

DERRICKS
American Hoist & Derrick Co.
Clyde Iron Works, Inc.

DETECTORS, TRAMP-IRON
General Electric Co., Apparatus Sales Div.
Industrial Physics & Electronics Co.
Stearns Magnetic Products

DETECTORS, MAGNETIC-ELECTRONIC
Dings Magnetic Separator Co.

DETONATOR BOXES, WOOD
King Powder Co., Inc.
Mine Safety Appliances Co.

DETONATORS, ELECTRIC
American Cyanamid Co., Explosives Dept. — "AMERICAN"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
King Powder Co., Inc.
Olin Mathieson Chemical Corp., Explosives Div.
National Powder Co.

DETONATORS, MILLISECOND-DELAY
American Cyanamid Co., Explosives Dept. —"AMERICAN"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
King Powder Co., Inc.
Olin Mathieson Chemical Corp., Explosives Div.
National Powder Co.

DETONATORS, SHORT DELAY
American Cyanamid Co., Explosives Dept. — "AMERICAN"
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
King Powder Co., Inc.
National Powder Co.

DETONATORS, SHORT-PERIOD DELAY
Hercules Powder Co.

DETONATORS, STANDARD-DELAY
American Cyanamid Co., Explosives Dept. — "AMERICAN"
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
King Powder Co., Inc.
Olin Mathieson Chemical Corp., Explosives Div.
National Powder Co.

DIAMONDS, INDUSTRIAL
Hoffman Bros. Drilling and Mfg. Co.
E. J. Longyear Co.
J. K. Smit & Sons
Sprague & Henwood, Inc.

DIAPHRAGMS, PUMPS, VALVES, ETC.
United States Rubber Co.

DIPPER TEETH, BASES, INSERTS, ETC.
American Brake Shoe Co., Amsco Div. — "AMSCO"
American Steel Foundries — "WEARPACT"
Electric Steel Foundry Co.
Kensington Steel, Div. of Poor & Co.
Koehring Co.
Marion Power Shovel Co.
Taylor-Wharton Co. Div., Harsco Corp.
H & L Tooth Co.

DIPPERS, SHOVEL
American Brake Shoe Co., Amsco Div. — "AMSCO"
Electric Steel Foundry Co.
Marion Power Shovel Co.

DISTRIBUTION BOXES, ELECTRICAL, STRIPPING
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Westinghouse Electric Corp.

DISTRIBUTION BOXES, ELECTRICAL, UNDERGROUND
Albert & J. M. Anderson Mfg. Co. — "POW-R-GARD," "GROUND-GUARD"
Ensign Electric & Mfg. Co.
G & W Electric Specialty Co.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Ohio Brass Co.
Schroeder Brothers Corp.
Westinghouse Electric Corp.

DISTRIBUTORS, COAL, SELF ROTATING
Denver Equipment Co. — "DENVER"

DISTRIBUTORS, HYDRAULIC COAL FEED
Deister Machine Co.
Denver Equipment Co. —"DENVER"
Heyl & Patterson, Inc.

DOCKS, LOADING, UNLOADING
Dravo Corp.

DOORS, AIR-POWERED
American Mine Door Co. — "CANTON"

DOORS, FURNACE-OBSERVATION, ACCESS
Bigelow-Liptak Corp.

DOORS, INDUSTRIAL STEEL
Steelcraft Mfg. Co.

DOORS, STEEL FIRE
Steelcraft Mfg. Co.

DOORS, MINE
American Mine Door Co. — "CANTON"
National Mine Service Co. Clarkson Div. — "CLARKSON"

DOORS, MINE, AUTOMATIC
American Mine Door Co. "CANTON"

DRAFT GEAR, RUBBER
Enterprise Wheel & Car Corp.
National Malleable & Steel Castings Co.—"NATIONAL MULTI-PAD"

DRAFTING EQUIPMENT, SUPPLIES
Charles Bruning Co., Inc.
Geo-Optic Co., Inc.
Keuffel & Esser Co.
Wild Heerbrugg Instruments, Inc.

DRAGLINES, CRAWLER
American Hoist & Derrick Co. —"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA"
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Clark Equipment Co., Construction Machinery Div.— "MICHIGAN"
Gar Wood Industries, Inc.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

DRAGLINES, RUBBER-TIRED
American Hoist & Derrick Co. —"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div. —"LIMA"
Bay City Shovels, Inc.
Bucyrus-Erie Co.

Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
Gar Wood Industries, Inc.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.
Unit Crane & Shovel Corp.

DRAGLINES, WALKING
Bucyrus-Erie Co.
Marion Power Shovel Co.
Page Engineering Co.

DRIERS, CENTRIFUGAL
Bird Machine Co.
Blaw-Knox Co.
Centrifugal & Mech. Industries, Inc.—"C-M-I"
Dorr-Oliver, Inc.
McNally-Pittsburg Mfg. Corp.

DRIERS, CENTRIFUGAL, SCREEN-TYPE SOLID-BOWL
Bird Machine Co.

DRIERS, CONTINUOUS ROTARY
Hardinge Co., Inc.

DRIERS, FLUIDIZED BED
Dorr-Oliver, Inc.

DRIERS, HEAT
Buttner Works, Inc.
J. D. Christian Engineers—"THERMOVEYORS"
Colorado Iron Works Co., A Sub. of Mine & Smelter Supply Co.
Combustion Engineering, Inc., Raymond Div.—"FLASH"
Nelson L. Davis Co.—"NELDCO"
Denver Equipment Co.
Dravo Corp.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Link-Belt Co., Dept. CAMGL 57—"ROTO-LOUVRE," "MULTI-LOUVRE"
McNally-Pittsburg Mfg. Corp.
Silver Engineering Works, Inc.—"PARRY TURBULENT ENTRAINMENT"
Western Precipitation Corp.
Westinghouse Electric Corp., B. F. Sturtevant Div.
Wyssmont Co., Inc.—"TURBO-DRYER"

DRILL AUGERS, COAL
Cardox Corp.
Central Mine Equipment Co.
Compton, Inc.
Dooley Brothers
Howells Mining Drill Co.
Kennametal, Inc.
Leetonia Tool Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling Inc.
National Mine Service Co.
Paris Mfg. Co.
Salem Tool Co.
Schroeder Brothers Corp.
Taylor-Wharton Co. Div., Harsco Corp.
Thor Power Tool Co.

DRILL AUGERS, STRIP OVERBURDEN
Cardox Corp.
Central Mine Equipment Co.
McLaughlin Mfg. Co., Inc.
Mobile Drilling Inc.
Paris Mfg. Co.
The Salem Tool Co.

DRILL BOXING
Leetonia Tool Co.

DRILL CORE BARRELS
E. J. Longyear Co.
Mobile Drilling Inc.

DRILL EXTRACTORS, MAGNETIC
Dings Magnetic Separator Co.

DRILL HEAD
Austin Powder Co.—"AUSTIN AP"

DRILL JUMBOS
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Gardner-Denver Company
Gibraltar Equipment & Mfg. Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mayo Tunnel & Mine Equipment Co.
B. J. Nykerk Corp.—"HAUSHERR"
Schroeder Brothers Corp.

DRILL PIPE
Davey Compressor Co.
George E. Failing Co.
Jones & Laughlin Steel Corp.
E. J. Longyear Co.
Mobile Drilling Inc.
National Supply Company—"SPANGWELD," "DOUBLE SEAL SHRINK THREAD"
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Stardrill-Keystone Co.
Varel Mfg. Co., Inc.

DRILL PRESSES
Farrel-Birmingham Co., Inc.
R. W. Nichols Co.—"ALKON," "AIR-HYDRAULIC"
South Bend Lathe Works

DRILL RODS
E. J. Longyear Co.
Mobile Drilling Inc.

DRILL SHARPENERS
Gardner-Denver Company
Ingersoll-Rand Co.
Stardrill-Keystone Co.—"ACME"

DRILL STEEL
Acme Machinery Co.
Bethlehem Steel Co.
Brunner & Lay, Inc.
Crucible Steel Co. of America—"VICTOR CRUCIBLE," "KETOS," "ALVA EXTRA," "NUDIE," "REX," "SPECIAL," "HALCOMB 218"
Davey Compressor Co.
Gardner-Denver Company
Gibraltar Equipment & Mfg. Co.
Howells Mining Drill Co.
Ingersoll-Rand Co.
Joy Mfg. Co.
Marathon Coal Bit Co., Inc.—"IRON CITY"
Mayheu Supply Co., Inc.
National Mine Service Co.
B. J. Nykerk Corp.—"HAUSHERR"
Schroeder Brothers Corp.
Thor Power Tool Co.
Varel Mfg. Co., Inc.

DRILL STEEL, HOLLOW
Crucible Steel Co. of America

DRILL THREAD BARS
Leetonia Tool Co.

DRILL TOOLS, CHURN
Spang & Company

DRILLING RIGS
National Supply Co.—"NATIONAL"

DRILLS, COAL, HAND
Ensign Electric & Mfg. Co.
Howells Mining Drill Co.
Leetonia Tool Co.
Mall Tool Co., Div. of Remington Arms Co., Inc.—"MALL," "REMINGTON"
B. J. Nykerk Corp.—"HAUSHERR"
Ohio Brass Co.
Penn Machine Co.
The Salem Tool Co.
Schroeder Brothers Corp.

DRILLS, COAL, HAND-HELD
Chicago Pneumatic Tool Co.—"WHIPPETT CP"
The Cincinnati Electrical Tool Co.
Ensign Electric & Mfg. Co.
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
Penn Machine Co.
The Salem Tool Co.
Schroeder Brothers Corp.

DRILLS, COAL, HAND-HELD HYDRAULIC
Chicago Pneumatic Tool Co.—"CP"
Jeffrey Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Penn Machine Co.
Schroeder Brothers Corp.

DRILLS, COAL, HYDRAULIC
The Long Co.

DRILLS, COAL, MOUNTED SELF-PROPELLED
Bucyrus-Erie Co.
Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Jeffrey Mfg. Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Lee-Norse Company—"DRILL TRUCK"
Mobile Drilling Inc.
B. J. Nykerk Corp.—"HAUSHERR"
Paris Mfg. Co.
Penn Machine Co.
The Salem Tool Co.
Stardrill-Keystone Co.—"SPEED STAR," "KEYSTONE," "FRANKS"
Winter-Weiss Co. — "PORTA-DRILL"

DRILLS, COAL, POST-MOUNTED
Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
Jeffrey Mfg. Co.
Leetonia Tool Co.
Morse Bros. Machinery Co.
Penn Machine Co.
The Salem Tool Co.

DRILLS, COAL RECOVERY
The Salem Tool Co.

DRILLS, COMPRESSED-AIR
Howells Mining Drill Co.—"HOWELLS"

DRILLS, CORE
Acker Drill Co. — "HILLBILLY," "TEREDO"
Chicago Pneumatic Tool Co.—"CP"
George E. Failing Co.
Hoffman Bro. Drilling and Mfg. Co.
Joy Mfg. Co.
E. J. Longyear Co.
Mobile Drilling Inc.
Pennsylvania Drilling Co.
Reich Bros. Mfg. Co., Inc.
Sprague & Henwood Inc.
Winter-Weiss Co. — "PORTA-DRILL"

DRILLS, CRAWLER-MOUNTED
Thor Power Tool Co.

DRILLS, ELECTRIC
Howells Mining Drill Co.—"SPRY"

DRILLS, HIGHWALL, HORIZONTAL, AUGER
The Salem Tool Co.

DRILLS, MASONRY
Metallurgical Products Dept., General Electric Co.—"CARBOLOY"
Pennsylvania Drilling Co., Masonry Drill Div.

DRILLS, OVERBURDEN, SIDEWALL
Chicago Pneumatic Tool Co. "CP"
Joy Mfg. Co.
Mobile Drilling Inc.
B. J. Nykerk Corp.—"HAUSHERR"
Paris Mfg. Co.
The Salem Tool Co.

DRILLS, OVERBUDEN, TRACTOR-MOUNTED PNEUMATIC
Chicago Pneumatic Tool Co.—"TRACDRIL"
Davey Compressor Co.
Gardner-Denver Company
Joy Mfg. Co. — "CHALLENGER"

B. J. Nykerk Corp.—"HAUSHERR"
Schramm, Inc.
Winter-Weiss Co. — "PORTA-DRILL"

DRILLS, OVERBURDEN, VERTICAL CHURN
Bucyrus-Erie Co.
Stardrill-Keystone Co.—"SPEED STAR," "KEYSTONE"

DRILLS, OVERBURDEN, VERTICAL ROTARY
Bucyrus-Erie Co.
Cardox Corp.
Davey Compressor Co.
George E. Failing Co.
Joy Mfg. Co.—"CHAMPION"
E. J. Longyear Co.
Mobile Drilling Inc.
B. J. Nykerk Corp.—"HAUSHERR"
Reich Bros. Mfg. Co., Inc.
The Salem Tool Co.
Schramm, Inc.
Stardrill-Keystone Co.— "KEYSTONE," "FRANKS"
Winter-Weiss Co. — "PORTA-DRILL"

DRILLS, PNEUMATIC
Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Cleco Div., Reed Roller Bit Co.
Davey Compressor Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mall Tool Co., Div. of Remington Arms Co., Inc.—"MALL," "REMINGTON"
B. J. Nykerk Corp.—"HAUSHERR"
Schramm, Inc.
Schroeder Brothers Corp.
Thor Power Tool Co.
Worthington Corp.

DRILLS, PORTABLE ELECTRIC
Black & Decker Mfg. Co.

DRILLS, PROSPECTING
Hossfeld Mfg. Co. — 'HOSSFELD DIRECT DRIVE"
Mobile Drilling Inc.
Reich Bros. Mfg. Co., Inc.

DRILLS, POWER-TAKE-OFF OPERATED
Mobile Drilling Inc.

DRILLS, ROCK, ELECTRIC, PORTABLE
Homelite, Div. Textron Inc.—"HOMELITE-(BOSCH)"

DRILLS, ROOF-BOLTING
Acme Machinery Co.
Chicago Pneumatic Tool Co.—"CP"
Dooley Brothers
J. H. Fletcher & Co.
Gardner-Denver Company
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Penn Machine Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

DRILLS, ROTARY, PERCUSSIVE
B. J. Nykerk Corp.—"HAUSHERR"

DRILLS, SHOCK
Acker Drill Co. Inc.

Cardox Corp.
Chicago Pneumatic Tool Co.—

DRILLS, STRIP-COAL, TRACTOR-MOUNTED PNEUMATIC
"H-BOOM"
Gardner-Denver Company
Joy Mfg. Co. — "CHALLENGER"
B. J. Nykerk Corp.—"HAUSHERR"
The Salem Tool Co.
Schramm, Inc.

DRILLS, STRIP-COAL, VERTICAL ELECTRIC
Cardox Corp.
Penn Machine Co.
The Salem Tool Co.

DRILLS, WAGON
Schroeder Brothers Corp
Thor Power Tool Co.

DRIVES, ADJUSTABLE SPEED
Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI-PITCH"
American Blower, Div. of American-Standard
The American Pully Co.
Electric Machinery Mfg. Co.—"AMPLI-SPEED"
General Electric Co., Apparatus Sales Div.
Link-Belt Co., Dept. CAMGL-57—"P. I. V."
Philadelphia Gear Works
Reliance Elec & Eng. Co. — "RELIANCE V*S"
Vickers, Inc.
Worthington Corp.

DRIVES, CHAIN
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.
The Four Wheel Drive Auto Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT"
Morse Chain Co.
National Supply Company — "NATIONAL"
Whitney Chain Co.

DRIVES, EMERGENCY, FANS, ETC.
Philadelphia Gear Works

DRIVES, FLUID
American Blower, Div. of American-Standard
Dodge Mfg. Corp.—"FLEXIDYNE"
Link-Belt Co., Dept CAMGL-57—"ELECTROFLUID"
Master Electric Co.
National Supply Company—"GYROL," "NATIONAL"
Twin Disc Clutch Co.

DRIVES, GEAR
The Louis Allis Co.
Baughman Mfg. Co., Inc.
Blaw-Knox Co.
J. D. Christian Engineers
Falk Corp.
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Co. — "GEARMOTOR," "LINE-O-MOTOR"
The Four Wheel Drive Auto Co.
Hewitt-Robins Incorporated—"JONES"
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT," "PARALLEL," "IN-LINE HELICAL," "WORM"
Master Electric Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
Reliance Elec. & Eng. Co.
U. S. Electrical Motors, Inc.—"SYNCRO-GEAR"

DRIVES, SELECTIVE-SPEED
Century Electric Co.
Link-Belt Co., Dept. CAMGL-57

DRIVES, SHAFT MOUNTED
Falk Corp.
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT"

DRIVES, V-BELT
Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"TEX-ROPE"
The American Pulley Co.
Bonded Scale & Machine Co.
Carlyle Rubber Co., Inc.
J. D. Christian Engineers
Dayton Rubber Co.
Dodge Mfg. Corp.
Flood City Brass & Electric Co.
Gates Rubber Co.
B. F. Goodrich Industrial Products Co.
Guyan Machy. Co.
Industrial Rubber Products Co. (W. Va.)
Industrial Rubber Products Co. (Pa.)
Iowa Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
New York Belting & Packing Co.—"GILMER"
Ore Reclamation Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"POLY-V"
Stephens-Adamson Mfg. Co.
Thermoid Co.
Worthington Corp.

DRIVES, VARIABLE-SPEED
Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI-PITCH"
The Louis Allis Co.
The American Pulley Co.
Bonded Scale & Machine Co.
J. D. Christian Engineers
Clark Controller Co.
Cleveland Worm & Gear Co.
Dodge Mfg. Corp.
Dynamatic Div., Eaton Mfg. Co.—"AJUSTO-SPEDE," "DYNASPEDE"
Foote Brothers Gear & Machinery Corp.—"VARI-MOUNT"
General Electric Co., Apparatus Sales Div.
Hewitt-Robins Incorporated
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57—"P. I. V."
Master Electric Co.
Philadelphia Gear Works
Reeves Pulley Co., Div. Reliance Electric & Engineering Co.—"VARI-SPEED"
Reliance Elec. & Eng. Co.—"RELIANCE V*S"
Schroeder Brothers Corp.
U. S. Electrical Motors, Inc.—"VARI-DRIVE"
Vickers, Inc.
Worthington Corp.

DRIVES, VARIABLE-SPEED, HYDRAULIC
American Engineering Co.—"HELE-SHAW"
Link-Belt Co., Dept. CAMGL-57

DRIVES, VARIABLE-SPEED. EDDY-CURRENT
The Louis Allis Co.
Dynamatic Div., Eaton Mfg. Co.—"AJUSTO-SPEDE," "DYNASPEDE"
Hewitt-Robins Incorporated
Kanawha Mfg. Co.

DRIVES, WORM-GEAR
Cleveland Worm & Gear Co.

DUCKBILL LOADING HEADS
Goodman Mfg. Co.

DUCKBILL LOADING HEADS, REBUILT
Leman Machine Co.

DUCT, AIR
Armco Drainage & Metal Prod., Inc.
C. R. Daniels Co.
Flexaust Co.—"FLEXAUST"
Kanawha Mfg. Co.
McNally-Pittsburg Mfg. Corp.

DUCT, BUS, ELECTRICAL
Distribution Assemblies Dept., General Electric Co.
I-T-E Circuit Breaker Co.
National Electric Products Co.
Revere Copper & Brass, Inc.
Square D Co.
Westinghouse Electric Corp.

DUCT, CABLE, ELECTRICAL
Flexaust Co.—"PLICA"
National Electric Products Co.
Square D Co.

DUMPS, CROSSOVER, KICKBACK
C. S. Card Iron Works
The Nolan Co.

DUMPS, ROTARY, MINE-CAR
C. S. Card Iron Works
Connellsville Mfg. & Mine Supply Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.

McNally-Pittsburg Mfg. Corp.
The Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wellman Engineering Co., McDowell Enterprise

DUST COLLECTOR TUBES

Bemis Bro. Bag Co.

DUST COLLECTORS, MECHANICAL, COAL HANDLING, PREPARATION

American Air Filter Co. Inc.
American Blower, Div. of American-Standards
Buttner Works, Inc.
The Ducon Co., Inc.
Fly Ash Arrestor Corp.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Koppers Co., Inc., Metal Products Div.
The R. C. Mahon Co.
Majac, Inc.
McNally-Pittsburg Mfg. Corp.
Pangborn Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Schroeder Brothers Corp.
Western Precipitation Corp.—"MULTICLONE"
Wheelabrator Corp. — "DUSTUBE"

DUST COLLECTORS MINE & DRILL

Acme Machinery Co.
American Air Filter Co. Inc.
Browning Dust Collector Co.
The Ducon Co., Inc.
J. H. Fletcher & Co.
Goodman Mfg. Co.
Mine Safety Appliances Co.

DUST COLLECTORS, VACUUM

Acme Machinery Co.
Mechanical Industries, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

DUST CONTROL SYSTEMS

Johnson-March Corp.—"CHEMJET"

DUST COUNTS

Commercial Testing & Engineering Co.

DUST-EXCLUDER BOATS

United States Rubber Co.—"MULTIFLEX"

DUST SEAL CURTAINS

United States Rubber Co.

DUSTPROOFING EQUIPMENT, HOT OIL

Viking Machinery Sales Corp.—"VIKING"

DUSTPROOFING EQUIPMENT, LIQUID COMPOUNDS

Johnson-March Corp.

DUST SAMPLERS

Fisher Scientific Co.
Mine Safety Appliances Co.—"MIDGET IMPINGERS"
Willson Products Div., Ray-O-Vac Co.

ELBOWS, RUBBER LINED

Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.—"USCOCITE PLASTIC"

ELEVATORS, BELT

Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Continental Gin Co.
Fairfield Engineering Co.
B. F. Goodrich Industrial Products Co.
Hewitt-Robins Incorporated
Kremser & Sons, Inc., Frank A.
Industrial Rubber Products Co. (Pa.)
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works, Inc.
E. F. Marsh Engrg. Co.—"MARCO"
Meckum Engrg. Co.
New York Belting & Packing Co.—"ARIMEX," "INDESTRUCTABLE," "INSPIRATION," "PALISADE"
Ore Reclamation Co.
K. Prins & Associates
Republic Rubber Div., Lee Rubber & Tire Co.
W. J. Savage Co.
Smith Engineering Works
Stevens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall Inc.
United States Rubber Co .

ELEVATORS, BUCKET

Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA," "AUSTIN-WESTERN"
Baughman Mfg. Co., Inc.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Heyl & Patterson, Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Koehring Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works, Inc.
E. F. Marsh Engrg. Co.—"MARCO"
McNally-Pittsburg Mfg. Corp.
Meckum Engrg Co.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.
Stephens-Adamson Mfg. Co.
Sturtevant Mill Co.
Transall Inc.
Universal Road Machinery Co.
Wilmot Engineering Co.

ELEVATORS, MEN & SUPPLIES

Mayo Tunnel & Mine Equipment Co.

ELEVATORS, MINE-TRANSFER, CAR-LOADING

—See Conveyors, Elevating

ENGINE FUELS, DIESEL

Standard Oil Co. (Ind.)

ENGINE-GENERATOR SETS

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Cummins Engine Co., Inc.
Detroit Diesel Engine Div., General Motors Corp.
Diesel Energy Corp.
Harnischfeger Corp.
Homelite, Div. Textron, Inc.—"HOMELITE"
Le Roi Div., Westinghouse Air Brake Co.
Lincoln Electric Co.—"WELDANPOWER"
Morse Bros. Machinery Co.
Murphy Diesel Co.
Nordberg Mfg. Co.—"POWER CHIEF"
Ready Power Co.—"READY POWER"
R. H. Sheppard Co., Inc.
Thor Power Tool Co.
Waukesha Motor Co.—"ENGINATORS"
White Diesel Engine Div., The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINE OILS, DIESEL

The American Oil Co.
Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Esso Standard Oil Co.—"ESSOLUBE HD" "ESTOR HD"
Gulf Oil Corp.
Shell Oil Co.
Sun Oil Co.—"DYNAVIS," "SOLNUS," "SUNVIS"
Swan-Finch Petrochemicals

ENGINEERS, BLASTING VIBRATION

Vibration Measurement Engineers, Inc.

ENGINEERS, CONSULTING, CONSTRUCTION

Allen & Garcia Co.
Baton & Co., Geo. S.
The Daniels Co. Contractors, Inc.

ENGINEERS, CONSULTING

Cement Gun Co., Inc.—"GUNITE"
Mobile Drilling Inc.
Paul Weir Co., Inc.
Nelson L. Davis Co.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works, Inc.
Manu-Mine Research & Development Co.
John F. Meissner Engineers, Inc.
K. Prins & Associates
Read, Davis
Robinson & Robinson
Stephens-Adamson Mfg. Co.
Taller & Cooper

ENGINEERS, CONSULTING, DESIGNING

Allen & Garcia Co.
Baton & Co., Geo. S.
Blaw-Knox Co.
The Daniels Co. Contractors, Inc.
Nelson L. Davis Co.
The Four Wheel Drive Auto Co.
Heyl & Patterson, Inc.
Leman Machine Co.
Link-Belt Co., Dept. CAMGL 57
Peter F. Loftus Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
John F. Meissner Engineers, Inc.
Mobile Drilling Inc.
Pierce Management, Inc.
K. Prins & Associates
Read, Davis
Robinson & Robinson
Stephens-Adamson Mfg. Co.
Taller & Cooper
Templeton-Mathews Corp.
Paul Weir Co., Inc.
Western Machinery Co.—"WKE"

ENGINEERS, CONSULTING, ELECTRICAL

Allen & Garcia Co.
General Nuclear Corp.
Herbert S. Littlewood
Peter F. Loftus Corp.
John F. Meissner Engineers, Inc.
National Electric Coil Co.
Robinson & Robinson
Taller & Cooper
United Engineers & Constructors, Inc.

ENGINEERS, CONSULTING, FLOTATION

Denver Equipment Co.—"DENVER"

ENGINEERS, CONSULTING, GEOLOGY

E. J. Longyear Co.
Manu-Mine Research & Development Co.
Mobile Drilling Inc.
Pennsylvania Drilling Co.
Pierce Management, Inc.
Robinson & Robinson
Paul Weir Co., Inc.
J. W. Woomer & Associates

ENGINEERS, CONSULTING, INDUSTRIAL

Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works, Inc.
Peter F. Loftus Corp.
John F. Meissner Engineers, Inc.
Robinson & Robinson
Stephens-Adamson Mfg. Co.

United Engineers & Constructors Inc.

ENGINEERS, CONSULTING, INSTRUMENT

Suverkrop Instruments.

ENGINEERS, CONSULTING, MECHANICAL

General Nuclear Corp.

ENGINEERS, CONSULTING, MINING

Allen & Garcia Co.
Baton & Co., Geo. S.
Cowin & Co., Inc.
Eavenson, Auchmuty & Greenwald
Fetterman Engineering Co.
Herold Mfg. Co.
Kirk & Cowin
Link-Belt Co., Dept. CAMGL-57
Peter F. Loftus Corp.
E. J. Longyear Co.
Alford, Newell G.
Nordberg Mfg. Co.
Pierce Management Inc.
Read, Davis
Robinson & Robinson
Paul Weir Co., Inc.
J. W. Woomer & Associates

ENGINEERS, CONSULTING, PREPARATION

Allen & Garcia Co.
Baton & Co., Geo. S.
Castanoli, Alder F.
Commercial Testing & Engineering Co.
Robert A. Cummings, Jr., & Associates
The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.
Eavenson, Auchmuty & Greenwald
Fairmount Machinery Co.
Fuel Process Co.
Heyl & Patterson, Inc.
Industrial Engrg. & Construction Co., Inc.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Peirce Management Inc.
K. Prins & Associates
Read, Davis
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Robinson & Robinson
Templeton-Matthews Corp.
Paul Weir Co., Inc.

ENGINEERS, CONSULTING, SOILS

Mobile Drilling Inc.

ENGINEERS, CONSULTING, STRIPPING

Allen & Garcia Co.
Baton & Co., Geo. S.
Eavenson, Auchmuty & Greenwald
Fetterman Engineering Co.
Peirce Management Inc.
Robinson & Robinson

ENGINEERS, MINE MANAGEMENT

Pierce Management Inc.

ENGINES, DIESEL

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Chicago Pneumatic Tool Co.
Compton, Inc.
Continental Motors Corp.
Cummins Engine Co., Inc.—"CUMMINS TURBODIESEL"
Detroit Diesel Engine Div., General Motors Corp.
Diesel Energy Corp.
Harnischfeger Corp.
Hercules Motor Corp.
International Harvester Co., Construction Equipment Div.
Minneapolis-Moline Co.
Murphy Diesel Co.
Nordberg Mfg. Co.
Oliver Corp.
Page Engineering Co.
R. H. Sheppard Co., Inc.
Waukesha Motor Co.
White Diesel Engine Div., The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINES, DIESEL AUTOMOTIVE

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Continental Motors Corp.
Detroit Diesel Engine Div., General Motors Corp.
Hercules Motor Corp.
Mack Trucks, Inc.
Waukesha Motor Co.

ENGINES, DUAL-FUEL

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Chicago Pneumatic Tool Co.
International Harvester Co., Construction Equipment Div.
Le Roi Div., Westinghouse Air Brake Co.
Murphy Diesel Co.
Nordberg Mfg. Co.—"DUA-FUEL"
Waukesha Motor Co.
White Diesel Engine Div., The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ENGINES, DUAL-FUEL, AIR COOLED

Wisconsin Motor Corp.

ENGINES, GASOLINE

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Cities Service Oil Co.
Continental Motors Corp.
Ford Motor Co.
Hercules Motor Corp.
International Harvester Co., Construction Equipment Div.
Le Roi Div., Westinghouse Air Brake Co.
Minneapolis-Moline Co.
Oliver Corp.
Reo Motors, Inc.
Waukesha Motor Co.

ENGINES, GASOLINE, AIR COOLED

Wisconsin Motor Corp,

ENGINES, GASOLINE AUTOMOTIVE

Allis-Chalmers Mfg. Co., Buda Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Continental Motors Corp.
Ford Motor Co.
Hercules Motor Corp.
International Harvester Co., Construction Equipment Div.
Le Roi Div., Westinghouse Air Brake Co.
Mack Trucks, Inc.
Waukesha Motor Co.

ENGINES, UNATTENDED, SAFETY PANELS

Stewart Warner Corp., Alemite Div.

ENGINES, OIL

Allis-Chalmers Mfg. Co., Buda Div.
Cities Service Oil Co.
Continental Motors Corp.
Hercules Motor Corp.
Nordberg Mfg. Co.
Waukesha Motor Co.
White Diesel Engine Div., The White Motor Co.—"WHITE SUPERIOR"
Worthington Corp.

ETCHERS, ELECTRIC

Martindale Electric Co.

EXHAUST OR FUME STACKS

Neff & Fry Co.

EXHAUSTERS

American Blower, Div. of American-Standard
Buffalo Forge Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Robinson Ventilating Co.
Roots-Connersville Blower Div., Dresser Industries, Inc.

EXPANSION PLUGS, ROOF-BOLTING

National Mine Service Co.
Ohio Brass Co.

EXPLORATION EQUIPMENT

Mobile Drilling Inc.

EXPLORATION SERVICE, GEOPHYSICAL

E. J. Longyear Co.

EXPLORATION SERVICE, GEOPHYSICAL GROUTING

Mobile Drilling Inc.

EXPLOSIVES — See also, Coal Breakers; Blasting Agents; Liquid Oxygen Explosives

EXPLOSIVES, COAL

American Cyanamid Co., Explosives Dept. — "AMERICAN"
Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.—"GELOBEL," "DUOBEL," "MONOBEL," "LUMP-COAL"
Hercules Powder Co.
Illinois Powder Mfg. Co.—"GOLD METAL"
King powder Co., Inc.
Liberty Powder Co., Sub. of Olin Mathieson Chemical Corp.
National Powder Co.
Olin-Mathieson Chemical Corp. Explosives Div.

EXPLOSIVES, LIQUID-OXYGEN TYPE

Airmite-Midwest, Inc.

EXPLOSIVES LOADING & TAMPING MACHINE, HORIZONTAL

Olin Mathieson Chemical Corp.

EXPLOSIVES PACKAGING, PLASTIC

Visking Co., Plastics Div.—"VIS QUEEN"

EXPLOSIVES, ROCK

American Cyanamid Co., Explosives Dept.—"AMERICAN"
Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.—"RED CROSS," "EXTRA," "GELEX"
Hercules Powder Co.
Illinois Powder Mfg. Co.—"GOLD METAL"
King Powder Co., Inc.
National Powder Co.,
Olin-Mathieson Chemical Corp., Explosives Div.

EYEBOLTS

Bethlehem Steel Co.
Crosby Laughlin Div., American Hoist & Derrick Co. — "CROSBY," "LAUGHLIN"
Duquesne Mine Supply Co.—"REDIPT"
Republic Steel—"REPUBLIC"
Upson-Walton Co.

EYE SHIELDS

American Optical Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Martindale Electric Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAFI-I-SHIELD," "SAFI-I-FLEX," "AIRFLOW"
Victor Equipment Co.
Wilson Products Div., Ray-O-Vac Co.

FABRICATORS, MACHINES, COMPONENTS

Connellsville Mfg. & Mine Supply Co.
The Daniels Co., Contractors, Inc.
Falk Corp.
Flood City Brass & Electric Co.
Galigher Co.
Robert Holmes & Bros., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Leman Machine Co.
Link Belt Co., Dept. CAMGL-57
R. C. Mahon Co.
Meckum Engr. Co.
Ore Reclamation Co.
W. J. Savage Co.
Simplicity Engineering Co.
Vulcan Iron Works
Wellman Engineering Co., McDowell Enterprise

FABRICATORS, STEEL & STRUCTURES

Arrowhead Steel Buildings, Inc.
Bethlehem Steel Co.
Blaw-Knox Co.
Butler Mfg. Co.
Connellsville Mfg. & Mine Supply Co.
The Daniels Co., Contractors, Inc.
Enterprise Wheel & Car Corp.
Fairmont Machinery Co.
Robert Holmes & Bros., Inc.
Industrial Engrg. & Construction Co., Inc.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
L. O. Koven & Bro., Inc.
Link-Belt Co., Dept. CAMGL-57
R. C. Mahon Co.
Meckum Engr. Co.
Ore Reclamation Co.
Phoenix Iron & Steel Co., Structural and Tube Divs.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Thomas Engineering & Construction Co.
Wellman Engineering Co., McDowell Enterprise
Wiley Mfg. Co.

FACE SHIELDS

American Optical Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Martindale Electric Co.
Mine Safety Appliances Co.—"FACEGARD," "SUPER-GARD," "MINIGARD"
Ore Reclamation Co.
Pulmosan Safety Equipment Co.
U. S. Safety Service Co.—"HALO"
Victor Equipment Co.
Willson Products Div., Ray-O-Vac Co.

FAN SIGNALS

Nachod & U. S. Signal Co.

FAN SIGNALS, REMOTE SYSTEMS

Femco, Inc.

FANS, CENTRIFUGAL

American Air Filter Co., Inc.

FANS, EXHAUST

Diehl Manufacturing Co.

FANS, VENTILATING

American Blower, Div. of American-Standard
Buffalo Forge Co.
E. K. Campbell Co.—"EKCCO"
Chelsea Fan and Blower Co., Inc.
Clarage Fan Co.
Coppus Engineering Corp.—"VANO," "VENTAIR"
The Dana Fan & Blower Corp.
Diehl Manufacturing Co.
Emglo Products Div., M. Glosser & Sons, Inc.
Fly Ash Arrestor Corp.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"VENTAMINE"
F. R. Hannon & Sons—"HANCO"
Hartzell Propeller Fan Co.
Ilg Electric Ventilating Co.—"ILG"
Jeffrey Mfg. Co.
Joy Mfg. Co.—"AXIVANE"
Robbins & Meyers, Inc.—"PROPELLAIR"
Robinson Ventilating Co.
Westinghouse Electric Corp.
Westinghouse Electric Corp., B. F. Sturtevant Div.—"SILENTVANE," "AXIFLO," "TURBOVANE"
L. J. Wing Mfg. Co.—"WINGFOIL"

FEED DISTRIBUTORS, COAL, REVOLVING

The Deister Concentrator Co.—"CONCENCO"
Deister Machine Co.
Heyl & Patterson, Inc.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

FEEDERS, APRON

Baldwin-Lima-Hamilton Corp, Construction Equipment Div.—"LIMA," "AUSTIN-WESTERN"
Barber-Greene Co.
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Diamond Iron Works, Div. Goodman Mfg. Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Morse Bros. Machinery Co.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.—"AMSCO"
Straub Mfg. Co., Inc.
Traylor Engineering & Mfg. Co.
Universal Engineering Co.—"WOBBLER"
Webster Mfg. Co. Inc.
Williams Patent Crusher & Pulv. Co.

FEEDER-RETARDERS, MINE CAR

The Nolan Co.

FEEDERS, BELT

B-I-F Industries, Inc. — "HI-WEIGH."
Barber-Greene Co.
Bonded Scale & Machine Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Denver Equipment Co.—"ADJUSTABLE STROKE"
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hardinge Co., Inc.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Industrial Physics & Electronics Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works
E. F. Marsh Engrg. Co.—"MARCO"
Meckum Engr. Co.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Transall Inc.
Universal Road Machinery Co.
Webster Mfg. Co. Inc.
Williams Patent Crusher & Pulv. Co.

FEEDERS, CHAIN

Link-Belt Co., Dept. CAMGL-57
Ross Screen & Feeder Co.—"ROSS"

FEEDERS, CHLORIDE, LIME, REAGENT, SALT, ETC.

B-I-F Industries, Inc.—"HI-WEIGH," "ROTODIP," "ADJUST-O-FEEDER," "CHEM-O-FEEDER," "PROPORTIONEER"
Denver Equipment Co.—"DENVER"
Fischer & Porter Co.—"FEEDRATOR"
Galigher Co.—"GEARY"
Jeffrey Mfg. Co.
Manzel Div., Houdaille Industries, Inc.
Morse Bros. Machinery Co.
W. J. Savage Co.
Schaffer Poidometer Co.
Syntron Co.

FEEDERS, CONTINUOUS-WEIGHING

B-I-F Industries, Inc. — "HI-WEIGH"
Hardinge Co., Inc.—"CONSTANT WEIGHT"
Industrial Physics & Electronics Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Merrick Scale Mfg. Co.—"FEEDOWEIGHT"
Schaffer Poidometer Co.
Syntron Co.

FEEDERS, GRIZZLY

Jeffrey Mfg. Co.
Link Belt Co., Dept. CAMGL-57
Nordberg Mfg. Co.

FEEDERS, MANGANESE

Continental Gin Co.

FEEDERS, MINE-CAR

Connellsville Mfg. & Mine Supply Co.
Fairmont Machinery Co.
Link Belt Co., Dept. CAMGL-57
The Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Schoeder Brothers Corp.
Stephens-Adamson Mfg. Co.

FEEDERS, OSCILLATING

Link Belt Co., Dept. CAMGL-57

FEEDERS, RECIPROCATING

American Conveyor Co.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA," "AUSTIN-WESTERN"
Barber-Greene Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
Diamond Iron Works, Div. Goodman Mfg. Co.
Fairfield Engineering Co.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
E. F. Marsh Engrg. Co.—"MARCO"
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

W. J. Savage Co.
Smith Engineering Works
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Transall Inc.
Webster Mfg. Co. Inc.
Wilmot Engineering Co.

FEEDERS, ROTARY FLOW
Link-Belt Co., Dept. CAMGL-57

FEEDERS, ROTARY TABLE
Link-Belt Co., Dept. CAMGL-57

FEEDERS, VIBRATING
Barber-Greene Co.
Cleveland Vibrator Co.
Eriez Manufacturing Co.
Fairfield Engineering Co.
Gruendler Crusher & Pulverizer Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Simplicity Engineering Co.—"OS-A-VEYOR"
Stephens-Adamson Mfg. Co.
Syntron Co.—"VIBRA-FLOW"

FENCE, FIELD
American Steel & Wire—"AMERICAN"

FENCING, CHAIN, LINK
American Chain & Cable Co. Inc., Page Steel & Wire Div.

FENCING, METAL
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"REALOCK," "CF&I"

FILES, RASPS
Henry Disston Div., H. K. Porter Co., Inc.
Martindale Electric Co.
The Salem Tool Co.
Simonds Saw & Steel Co.—"RED TANG"
Snap-on Tools Corp.

FILTER, CLOTH, MEDIA
C. R. Daniels Co.
Eimco Corp.
Filter Fabrics, Inc.
Fisher Scientific Co.
Johns-Manville—"CELITE"
Koppers Co., Inc., Metal Products Div.
Mine Safety Appliances Co.
National Filter Media Corp.
Newark Wire Cloth Co.
Peterson Filters & Engineering Co.—"TFR DRUM"
Riegel Textile Corp.—"RIEGEL"

FILTER CLOTH, METALLIC
W. S. Tyler Co.

FILTERS, AIR
American Air Filter Co., Inc.
A. W. Cash Valve Mfg. Corp.
Coppus Engineering Corp.
The Ducon Co., Inc.
Filter Fabrics, Inc.
Goodyear Tire & Rubber Co.—"PLIATRON"
Lincoln Engrg. Co.—"FULFLO"
Mine Safety Appliances Co.
New Jersey Meter Co.—"DRI AIR"
R. W. Nichols Co.—"M-B"
Victor Equipment Co.
Western Precipitation Corp.—"DUALAIRE"
Wheelabrator Corp.

FILTERS, CENTRIFUGAL, SOLIDS-LIQUID
Colorado Iron Works Co., A Sub. of Mine Smelter & Supply Co.

FILTERS, DISC, DRUM, VACUUM
Bird Machine Co.
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Eimco Corp.
Filter Fabrics, Inc.
Koppers Co., Inc., Metal Products Div.—"AERO TURN"
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.—"TPA DISC," "TFR DRUM"

FILTERS, ELECTRIC INSULATING
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section—"PERMAFIL"

FILTERS, FUEL, HYDRAULIC & LUBE OILS, PORTABLE & LINE
Schroeder Brothers Corp.

FILTERS, HORIZONTAL
Bird Machine Co.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Eimco Corp.
Filter Fabrics, Inc.

FILTERS, FUEL, HYDRAULIC & LUBE OILS
A. W. Cash Valve Mfg. Corp.
Compton, Inc.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Filter Fabrics, Inc.
R. W. Nichols Co.
United States Rubber Co.—"A.C. OIL"

FILTERS, MAGNETIC
Magnetic Engrg. & Mfg. Co.

FILTERS, PRESSURE
S. P. Kinney Engineers, Inc.

FILTERS, WATER
Bird Machine Co.
A. W. Cash Valve Mfg. Corp.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Kling Bros. Engineering Works—"KLING," "HYDRO (PRECOAT)," "ROTARY (AUTOMATIC)"
The Permutit Co.

FIRE ALARMS
Walter Kidde & Co., Inc.—"KIDDEATMO"
United States Rubber Co.

FIRE TRUCKS, APPARATUS
American-LaFrance Corp.—"AMERICAN LA FRANCE"
Ansul Chemical Co.—"ANSUL"
The Four Wheel Drive Auto Co.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Mine Safety Appliances Co.

FIRE BRICK
Johns-Manville—"J-M," "SIL-O-CEL"
Mexico Refractories Co.—"JAY BEE," "RAJAH," "AZTEX," "BIG SAVAGE," "MO-REX," "NILES NO. 1," "NILES H&B," "ALUMEX 50, 60 70 & 80," "M-20, M-23, M-26," "BIG 4," "THOR," "VIKING," "DINAS," "VAN DYKE"

FIRE CARS, TRUCKS, UNDERGROUND
Irwin Foundry & Mine Car Co.
Mine Safety Appliances Co.

FIRE-EXTINGUISHER FLUIDS
American Minechem Co.
Fyr-Fyter Div.
Stop Fire, Inc.
United States Rubber Co.

FIRE EXTINGUISHER RECHARGES
American-LaFrance Corp.—"AMERICAN LA FRANCE"

FIRE EXTINGUISHERS
American-LaFrance Corp.—"AMERICAN LA FRANCE"
Fyr-Fyter Div.
Guyan Machy. Co.—"KIDDE"
Walter Kidde & Co., Inc.—"FYRE-FREEZ," "KIDDE"
National Mine Service Co.
Pulmosan Safety Equip. Co.
Stop Fire, Inc.—"STOP-FIRE"
Swan-Finch Oil Petrochemicals—"AEROSOL"
United States Rubber Co.

FIRE EXTINGUISHERS, DRY CHEMICAL & WATER
Ansul Chemical Co.—"ANSUL"

FIRE FIGHTING EQUIPMENT HIGH PRESSURE FOG
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

FIRE HOSE
American-LaFrance Corp.—"AMERICAN LA FRANCE," "GOODYEAR"
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Fyr-Fyter Div.
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.—"UNDERWRITERS"
Hewitt-Robins Incorporated—"MALTESE CROSS"
Industrial Rubber Products Co. (Pa.)
New York Belting & Packing Co.—"AFMIC," "DELTA CARBOLIZED," "DUNDEE"
Quaker Rubber Div., H. K. Porter Co.—"QUAKER," "QUAKER PIONEER"
Republic Rubber Div., Lee Rubber & Tire Co.—"REPUBLIC"
United States Rubber Co.

FIRE NOZZLES
Bete Fog Nozzle, Inc.

FIRE-PROTECTION SYSTEMS
American-LaFrance Corp.—"ALFITE CO2," "FOAMITE AIRFOAM"
Cardox Corp.
Fyr-Fyter Div.
Grinnell Co., Inc.
Walter Kidde & Co., Inc.—"KIDDE CARBON DIOXIDE"

FIRE PROTECTION SYSTEMS, DRY CHEMICAL
Ansul Chemical Co.—"ANSUL"

FIRST-AID EQUIPMENT
E. D. Bullard Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.—"ALL-WEATHER"
National Mine Service Co.
Pulmosan Safety Equip. Co.

FITTINGS, CHAIN
American Hoist & Derrick Co.

FITTINGS, GREASE
Guyan Machy. Co.—"ALEMITE"
Keystone Lubricating Co.
Leman Machine Co.
Ore Reclamation Co.
Stewart-Warner Corp., Alemite Div.

FITTINGS, TUBE
Weatherhead Co., Fort Wayne Div.

FITTINGS, WIRE ROPE
American Hoist & Derrick Co.

FLAME CUTTING MACHINES
Air Reduction Sales Co., A Div of Air Reduction Co. Inc.

FLAME SAFETY LAMPS
Mine Safety Appliances Co.
National Mine Service Co.

FLANGED MOUNTINGS, ANTI-FRICTION BEARING
Link-Belt Co., Dept. CAMGL-57
SKF Industries, Inc.

FLASHLIGHTS, SAFETY & INDUSTRIAL
E. D. Bullard Co.
General Scientific Equipment Co.
Graybar Elec. Co., Inc.

Mine Safety Appliances Co.

FLEXIBLE SHAFT MACHINES, GRINDING

Martindale Electric Co.

FLIGHTS, CONVEYOR LINE

Remaly Mfg. Co., Inc.

FLOAT & SINK TEST SOLUTIONS

American Minechem Co. "CERTIGRAV"

FLOAT & SINK TESTERS

Commercial Testing & Engineering Co.
The Daniels Co., Contractors, Inc.
Robert Holmes & Bros., Inc.
Reich Bros. Mfg. Co., Inc.— "DELATESTER"

FLOCCULATING AGENTS

American Cyanamid Co., Mining Chemicals Dept. — "AEROFLOC"
American Minechem Co.— "CHEMFLOC"
Denver Equipment Co.
B. F. Goodrich Chemical Co.— "GOOD-RITE K-720"
Hercules Powder Co.
Hodag Chemical Corp.

FLOODLIGHTS

Crouse-Hinds Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Graybar Elec. Co., Inc.
Homelite, Div. Textron Inc.— "HOMELITE"
National Mine Service Co.
Phoenix Metal Products, Metal Spinning Div.— "STURDILITE"

FLOODLIGHTS, PORTABLE

Mine Safety Appliance Co.

FLOOR PLATE

U. S. Steel Corp.— "USS MULTIGRIP"

FLOOR RESURFACES

Steelcote Mfg. Co.—"FLOOR-NU"
Stonhard Co. Inc. — "STONPACH," "STONCAP," "STONHARD RESURFACER"

FLOORING, OPEN STEEL

Blaw-Knox Co.

FLOORING, WOOD BLOCK

Republic Creosoting Co.

FLOTATION CONDITIONERS

American Minechem Co.
The Daniels Co., Contractors, Inc.
Denver Equipment Co.— "DENVER"
Morse Bros. Machinery Co.
Western Machinery Co.— "WEMCO FAGERGREN"

FLOTATION FROTHERS

American Cyanamid Co., Mining Chemicals Dept.— "AERO FROTH"
American Minechem Co.
Denver Equipment Co.

FLOTATION LAB MACHINES

Denver Equipment Co.— "DENVER SUB-A"
Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.
Western Machinery Co.— "WEMCO FAGERGREN"

FLOTATION MACHINES

American Well Works
Bulkley, Dunton Processes, Inc.
The Daniels Co., Contractors, Inc.
Denver Equipment Co.— "DENVER SUB-A"
Galigher Co.—"AGITAIR"
Morse Bros. Machinery Co.— "JETAIR"
Ore Reclamation Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
The Stearns-Roger Mfg. Co.
Western Machinery Co.— "WEMCO FAGERGREN"
Wilmot Engineering Co.

FLOTATION PLANTS, PORTABLE

Bulkley, Dunton Processes, Inc.
The Daniels Co., Contractors, Inc.
Denver Equipment Co.— "DENVER SUB-A"

FLOTATION REAGENTS

American Cyanamid Co., Mining Chemicals Dept.
American Minechem Co.— "CHEMFROTH"
Denver Equipment Co.
The Dow Chemical Co.— "DOWFROTH 250"
Hercules Powder Co.
Hodag Chemical Corp.

FLOTATION TESTING LABORATORIES

Commercial Testing & Engineering Co.
Denver Equipment Co.— "DENVER"
Galigher Co.

FLOW METERS

B-I-F Industries, Inc.

FLUIDS, HYDRAULIC —

See Hydraulic Fluids

FLUID POWER PUMP GENERATORS, VALVE CONTROLS, MOTOR DRIVES, CYLINDER DRIVES

The Commercial Shearing & Stamping Co.

FLUX, WELDING, SALVAGE EQUIPMENT

Robert Holmes & Bros., Inc.

FOOTMATS

Onox, Inc.

FORGINGS

Timken-Detroit Axle Div., Rockwell Spring and Axle Co.

FORGINGS, DROP

Ladish Co.

FORGINGS, UPSET

New Departure Div., General Motors Corp.

FREEZEPROOFING CHEMICALS

American Minechem Co.
Fuel Process Co.
Morton Salt Co.—"FORMULA 5"
Wyandotte Chemicals Corp., Michigan Alkali Div.

FREEZEPROOFING OILS

Standard Oil Co. (Ind.)

FUEL OIL

Gulf Oil Corp.

FUELS

Pennsylvania Refining Co.

FURNACE ENCLOSURES

Bigelow-Liptak Corp.

FURNACE WALLS AND ARCHES

George P. Reintjes Co.

FURNACES, ARCH AND WALL CONSTRUCTION

Bigelow-Liptak Corp.

FURNACES, HEAT DRYING

Bigelow-Liptak Corp.
Colorado Iron Works Co., A Sub. of Mine & Smelter Supply Co.—"SKINNER"
Robert Holmes & Bros., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

FURNACES, HEAT TREATING

Hevi-Duty Electric Co.

FURNACES, HEATING

E. K. Campbell Co.—"THERMIDAIRE"
Dallas Engineers Inc., Coal-O-Matic Div. — "ANTHRAFLOW," "COAL-O-MATIC"

FURNACES, LABORATORY COMBUSTION

Central Scientific Co.
Fisher Scientific Co.
Hevi-Duty Electric Co.

FURNACES, METAL-MELTING

Kuhlman Elec. Co.

FURNACES, PLANT-HEATING, DIRECT-FIRED WARM-AIR

E. K. Campbell Co.—"THERMIDAIRE"

FURNACES, WARM-AIR, HEAVY-DUTY

E. K. Campbell Co.—"THERMIDAIRE"

FUSE, DETONATING

Atlas Powder Co.
Austin Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Ensign-Bickford Co.—"PRIMACORD"
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

FUSE, SAFETY, BLASTING

Atlas Powder Co.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Ensign-Bickford Co.
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

FUSE HOLDERS, BLASTING

National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

FUSE HOLDERS, ELECTRICAL

Bussmann Mfg. Co—"BUSS"
Circuit Protective Devices Dept., General Electric Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
Square D Co.

FUSE REDUCERS, ELECTRICAL

Bussmann Mfg Co.—"BUSS"
Holub Industries, Inc.
Ideal Industries, Inc.
Square D Co.
Trico Fuse Mfg. Co.

FUSES, ELECTRICAL

Bussmann Mfg. Co.—"BUSS FUSETRON"
Economy Fuse & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"BUSSMAN"
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Standard Devices Co.
Trico Fuse Mfg. Co.—"TRICO"
Westinghouse Electric Corp.

GAGES, LIQUID-LEVEL

Lunkenheimer Co.—"LUNKENHEIMER"

GAGES, TRACK

Aldon Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Leetonia Tool Co.
Nordberg Mfg. Co.
West Virginia Works, Conners Steel Div.

GAGES, PRESSURE, VACUUM

The Bristol Co.—"BRISTOLS"
Fischer & Porter Co.
Foxboro Co.
Hays Corp.
Helicoid Gage Div., American Chain & Cable Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Division
R. W. Nichols Co.
Victor Equipment Co.

GALVANOMETERS, BLASTING
American Cyanamid Co., Explosives Dept.
Hercules Powder Co.

GARAGES, PREFAB STEEL
Steelcraft Mfg. Co.

GAS DETECTORS, MINE
General Scientific Equipment Co.
Mine Safety Appliances Co.—"W-8 METHANE, M-6 METHANE"
National Mine Service Co.

GAS MASKS
E. D. Bullard Co.
Mine Safety Appliances Co.—"ALL-SERVICE"
Pulmosan Safety Equip. Co.
Willson Products Div., Ray-O-Vac Co.

GASKETS & MATERIALS
Anchor Packing Co.
Garlock Packing Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.—"PALMETTO"
Hewitt-Robins Incorporated
Johns-Manville—"GOETZE SPIROTALLIC"
New York Belting & Packing Co.—"FIRO GREAT SEAL INDESTRUCTIBLE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"R/M"
United States Rubber Co.

GASOLINE HAMMERS
Syntron Co.

GEAR DRESSING
Swan-Finch Petrochemicals—"AEROSOL"

GEARMOTORS
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Louis Allis Co.
Century Electric Co.
J. D. Christian Engineers—"RITE-LO-SPEED"
Cone-Drive Gears Div., Michigan Tool Co.
Continental Gin Co.
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Falk Corp.—"MOTOREDUCERS ALL-MOTOR"
Foote Brothers Gear & Machinery Corp.
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT," "GEARMOTORS," "MOTOGEARS"
Master Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Ore Reclamation Co.
Philadelphia Gear Works
Reliance Elec. & Eng. Co.
W. J. Savage Co.
Transall, Inc.
Westinghouse Electric Corp.

GEARMOTORS, REBUILT
Leman Machine Co.

GEARS
J. D. Christian Engineers
Continental Gin Co.
Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Flood City Brass & Electric Co.
Foote Brothers Gear & Machinery Corp.—"DUTI-RATED"
Four Wheel Drive Auto Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kelly Mfg. Co.—"KEMCO"
S. P. Kinney Engineers, Inc.
Link-Belt Co., Dept. CAMGL-57
Marathon Coal Bit Co. Inc.—"MARATHON," "TRACY"
McNally-Pittsburg Mfg. Corp.
Mosebach Electric & Supply Co.
Penn Machine Co.
Philadelphia Gear Works
Pittsburgh Gear Co.
W. J. Savage Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall Inc.
Vulcan Iron Works
West Virginia Armature Co.
Westinghouse Electric Corp.
Wilmot Engineering Co.

GEARS, MINE-LOCOMOTIVE, HEAT-TREATED
Penn Machine Co.

GEARS, PLASTIC
United States Rubber Co.

GEARS, REVERSE & REDUCTION
Twin Disc Clutch Co.

GEARS, SEMI-STEEL
Link-Belt Co., Dept. CAMGL-57
McLanahan & Stone Corp.

GEARS, WORM
Cone-Drive Gears Div., Michigan Tool Co.
Link-Belt Co., Dept. CAMGL-57

GEOPHYSICAL SURVEYS, AIRBORNE
Fairchild Aerial Surveys, Inc.

GLOVES
American Optical Co.
General Scientific Equipment Co.
Johns-Manville
Mine Safety Appliances Co.—"ALL-PURPOSE"
Pulmosan Safety Equip. Co.
Riegel Textile Corp.—"RIEGEL NO-BREAK-IN"

GLOVES, RUBBER
Continental Rubber Works
Fisher Scientific Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL," "NEOPRENE"
Graybar Elec. Co., Inc.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
United States Rubber Co.

GOGGLE-CLEANING STATIONS
American Optical Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAF-I-CUP"

GOGGLES
American Optical Co.
Bausch & Lomb Optical Co.
E. D. Bullard Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Marathon Coal Bit Co. Inc.—"WILSON"
Martindale Electric Co.
Mine Safety Appliances Co.—"SOFTSIDES"
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAF-I-CUP"
Victor Equipment Co.
Willson Products Div., Ray-O-Vac Co.

GRADER BLADES
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Steel Foundries—"WEARPACT"
Caterpillar Tractor Co.
Colorado Fuel & Iron Corp.—"CF&I"
Electric Steel Foundry Co.
Galion Iron Works & Mfg. Co.

GRADERS, MOTOR
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton Corp.
Caterpillar Tractor Co.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER-WARCO"
LeTourneau-Westinghouse Co.

GRAPHITE, LUBRICATING & GREASES
The American Oil Co.
Joseph Dixon Crucible Co.
Esso Standard Oil Co.
Jet-Lube, Inc.
Keystone Lubricating Co.

GRATING, FLOOR, STAIR
Butler Mfg. Co.
Dravo Corp.
Hendrick Mfg. Co.
J. Z. Zurn Mfg. Div., Zurn Industries, Inc.—"ZURN"

GREASE-LINE EXTENSIONS
National Mine Service Co. (Clarkson Div.)—"CLARKS"

GREASES
The American Oil Co.
Bearings, Inc.
Cities Service Oil Co.
Gulf Oil Co.
Fiske Bros. Refining Co.—"LUBRIPLATE"
Pure Oil Co.—"POCO HYPRONOX," " POCO HT-EP," "POCO GEARSHIELD," "PURO"

GREASES, HEAT & WATER RESISTANT
Swan-Finch Petrochemicals

GREASES, LITHIUM BASE
Sun Oil Co.—"PRESTIGE"

GREASES, MINE CAR
Pennsylvania Refining Co.
Sun Oil Co.

GREASES, RUST-PREVENTIVE
Sun Oil Co.

GRINDERS, PEDESTAL, TOOL
South Bend Lathe Works

GRINDERS, PORTABLE
Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
The Cincinnati Electrical Tool Co.
Cleco Div., Reed Roller Bit Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"BLACK & DECKER"
Ingersoll-Rand Co.
Mall Tool Co., Div of Remington Arms Co., Inc.—"MALL," REMINGTON"
Joseph T. Ryerson & Son, Inc.
Thor Power Tool Co.

GRINDING WHEELS
Guyan Machy. Co.—"CARBORUNDUM"
Kennametal, Inc.
Marathon Coal Bit Co. Inc.—"SIMONDS"
Norton Co.—"ALUNDUM CRYSTOLON"
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"MANHATTAN"
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
United States Rubber Co.

GRINDING WHEELS, DIAMOND
Hoffman Brothers Drilling Co.
Norton Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
J. K. Smit & Sons—"SECOMET"

GRIZZLIES
American Brake Shoe Co., Amsco Div.—"AMSCO"
Diamond Iron Works, Div. Goodman Mfg. Co.
Hewitt-Robins Incorporated
Iowa Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works Inc.
McNally-Pittsburg Mfg. Corp.
Nordberg Mfg. Co. — "SYMONS"
Simplicity Engineering Co.
Smith Engineering Works

Stephens-Adamson Mfg. Co.—"LIVE-ROLL"
Traylor Engineering & Mfg. Co.
W. S. Tyler Co.—"TY-ROCK TYLER NIAGARA"
Universal Engineering Co.

GRIZZLIES, VIBRATING
Syntron Co.

GRINDERS, STATIONARY
Cincinnati Electrical Tool Co.
Fisher Scientific Co.
Lippmann Engrg. Works Inc.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.

GRIZZLY BARS
American Brake Shoe Co., Amsco Div.—"AMSCO"
American Steel Foundries—"WEARPACT"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"C F & I"
Hewitt-Robins Incorporated
Kensington Steel, Div. of Poor & Co.
National Malleable & Steel Castings Co.
Nordberg Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.

GROUND CLAMPS
Albert & J. M. Anderson Mfg. Co.
Delta-Star Electric Div., H. K. Porter Co. (Delaware)
Duquesne Mine Supply Co.
Erico Products, Inc.—"CADDY"
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"
Tweco Products, Inc.—"TWECO"
Victor Equipment Co.

GROUND DETECTORS
Central Mine Supply Co Div., Pickard Industries, Inc. "PROTECTO"

GROUND INDICATORS, ELECTRICAL
Schroeder Brothers Corp.

GROUND RODS
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Graybar Elec. Co., Inc.
St. Louis Screw & Bolt Co.

GROUSER BARS
American Brake Shoe Co., Amsco Div.—"AMSCO"
Kensington Steel, Div. of Poor & Co.

GROUTING
Cement Gun Co. "GUNITE"
Hoffman Brothers Drilling Co.
E. J. Longyear Co.
Mott Core Drilling Co.
Pennsylvania Drilling Co.
Sika Chemical Corp.
Sprague & Henwood

GROUTING EQUIPMENT
Koehring Co.
Sprague & Henwood

HACK-SAW BLADES
Henry Disston Div., H. K. Porter Co., Inc.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"DISSTON"
Simonds Saw & Steel Co.—"RED END"
Snap-on Tools Corp.

HAMMERS, AIR
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
R. W. Nichols Co.
B. J. Nykerk Corp.—"HAUSHERR"
Penn Machine Co.
Schroeder Brothers Corp.
Thor Power Tool Co.
Worthington Corp.

HAMMERS, ELECTRIC
Homelite, Div. Textron Inc.—"HOMELITE-(BOSCH)"

HAMMERS, PORTABLE ELECTRIC
Black & Decker Mfg. Co.

HAMMERS, REPLACEABLE SOFT-FACE
Greene, Tweed & Co.—"ASA"
Snap-on Tools Corp.

HANDLES, TOOL
Leetonia Tool Co.
Marion Handle Mills, Inc.—"ACE, VIRGINIAN, A GRADE"
The Salem Tool Co.

HANGERS, SHAFT—SEE SHAFT HANGERS

HARDFACING FLUXES
Lincoln Electric Co.—"H535," "H545," "H550," "H560."

HARDFACING MATERIALS
Air Reduction Sales Co., A Div. Air Reduction Co., Inc.
Alloy Rods Co.—"WEAR-ARC," "WEAR-FLAME"
American Brake Shoe Co., Amsco Div.—"AMSCO"
Ampco Metal, Inc.—"AMPCO TRODE"
Coast Metals, Inc.
Crucible Steel Co. of America, "REXWELD"
Eutectic Welding Alloys Corp.—"EUTECHROMS"
Lincoln Electric Co.—"ABRASOWELD," "MANGANWELD," "JET-HARD BU 90," "FACEWELD," "SURFACEWELD," "STAINWELD," "TOOLWELD"
Marathon Coal Bit Co. Inc.—"AIRCO"
Resisto-Loy Co., Inc.—"RESISTO-LOY, ISOROD, MANGA-TONE, NM," "CHROMO-LOY," "FLINTYPE V. H.," "TWO-TONE T. H.," "MANGA-KOTE"
Sight Feed Generator Co.—"REXARC"
Stoody Co.
Stulz-Sickles Co.—"SEACO"
Taylor-Wharton Co. Div. Harsco Co.—"TIMANG"
Victor Equipment Co.
Wall Colmonoy Corp.—"COLMONOY"

HARDFACING WIRE
Drawalloy Corp.—"WEAR-O-MATIC"

HAULAGES, R. R. CAR BOAT
Welman Engineering Co., McDowell Enterprise

HAULERS, FLAT-BED
LeTourneau-Westinghouse Co.

HAULING UNITS
Athey Products Corp.

HAULING UNITS, RUBBER TIRED
Athey Products Corp.

HAULS, CAR
Link-Belt Co., Dept. CAMGL-57

HEADLIGHTS
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Guyan Machy. Co—"GUYAN"
Imperial-Cantrell Mfg. Co—"i. c."
Jeffrey Mfg. Co.

HEADLIGHTS, MINE LOCOMOTIVE
Schroeder Brothers Corp.

HEATER PANEL & UNITS
United States Rubber Co.—"USKON"

HEATERS, HOSE
United States Rubber Co.

HEATERS, OIL
C. R. Daniels Co.
Dravo Corp.
Hauck Mfg. Co.

HEATERS, UNIT
American Air Filter Co., Inc.
American Blower, Div of American-Standard "BENTURAFIN"
Buffalo Forge Co.
E. K. Campbell Co.—"THERMIDAIRE"
Clarage Fan Co.
Dravo Corp.
Graybar Elec. Co., Inc.
Ilg Electric Ventilating Co.—"ILG"
Westinghouse Electric Corp., B. F. Sturtevant Div.—"SPEED-HEATERS"
L. J. Wing Mfg. Co.—"WING REVOLVING"
Worthington Corp.

HEATING CABLE, LEAD-SHEATHED
Rockbestos Products Corp.

HEATING PLANTS
Axeman-Anderson Co.
Dravo Corp.

HEAVY-MEDIA RECLAMATION SYSTEMS
Colorado Iron Works Co., A. Sub. of Mine & Smelter Supply Co.—"AKINS"
The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Denver Equipment Co.—"DECO"
Jeffrey Mfg. Co.
Simplicity Engineering Co.
Western Machinery Co.—"WEMCO"

HEAVY-MEDIA SEPARATION PROCESS
American Cyanamid Co., Mining Chemicals Dept.
Colorado Iron Works Co., A Sub. of Mine & Smelter Supply Co.—"AKINS"
The Daniels Co. Contractors, Inc.—"DMS"
Nelson L. Davis Co—"NELDCO"
Dravo Corp.
Fairmont Machinery Co.
Fuel Process Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stearns Magnetic Products

HEAVY-MEDIA SEPARATORS
Hardinge Co., Inc.
Link-Belt Co., Dept. CAMGL-57

HIGH VOLTAGE INTERRUPTING DEVICES
Delta-Star Electric Div., H. K. Porter Co. (Delaware)

HINGES, MINE-DOOR
National Mine Service Co. (Clarkson Div.)—"CLARKSON"

HITCHINGS, MINE-CAR
American Car & Foundry Div., ACF Indusrties, Inc.
C. S. Card Iron Works
Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
National Malleable & Steel Castings Co.
Sanford Day Iron Works, Inc.

HOIST CONTROLLERS
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co

Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Industrial Physics & Electronics Co.
Morse Bros. Machinery Co.
Shepard Niles Crane & Hoist Corp.
Square D Co.
Vulcan Iron Works

HOIST HOOKS

Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
E. D. Bullard Co.
Duquesne Mine Supply Co.
Upson-Walton Co.

HOIST SIGNALLING COMMUNICATION

Femco, Inc.—"CAGE-PHONE"
Industrial Physics & Electronics Co.
Mine Safety Appliances Co.—"HOISTPHONE"

HOISTS, AIR

Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.

HOISTS, CONSTRUCTION

American Hoist & Derrick Co.

HOISTS, ELECTRIC

American Engineering Co.—"LO-HED"
J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"QUIK-LIFT"
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"SHAW-BOX"
Harnischfeger Corp.—"ZIP-LIFT," "HEVILIFT"
Robert Holmes & Bros., Inc.
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc.
Shaw-Box Crane & Hoist Div.—"BUDGIT," "LOAD-LIFTER"
Mobile Drilling Inc.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
The Oster Mfg. Co.
Robbins & Meyers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
The Stearns-Roger Mfg. Co.
Stephens-Adamson Mfg. Co.
Vulcan Iron Works
Wellman Engineering Co., McDowell Enterprise
Yale & Towne Mfg. Co.

HOISTS, ELECTRIC AND GASOLINE

Clyde Iron Works, Inc.

HOISTS, GASOLINE

Joy Mfg. Co.

HOISTS, HAND

J. D. Christian Engineers
Coffing Hoist Div., Duff-Norton Co.—"SAFETY PULL," "SUPER POWER"
Denver Equipment Co.—"DENVER"
Graybar Elec. Co., Inc.
Harnischfeger Corp.
Robert Holmes & Bros., Inc.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUGIT," "SHAW BOX"
Morse Bros. Machinery Co.
Ore Reclamation Co.
The Oster Mfg. Co.
Robbins & Meyers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Stephens-Adamson Mfg. Co.
Yale & Towne Mfg. Co.

HOISTS, LAYER-LOADING

Robert Holmes & Bros, Inc.
Sanford Day Iron Works, Inc.

HOISTS, LOADING-BOOM

Morse Bros. Machinery Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sanford Day Iron Works, Inc.
Shepard Niles Crane & Hoist Corp.

HOISTS, MONORAIL

American Engineering Co.—"LO-HED"
Coffing Hoist Div., Duff-Norton Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUGIT," "SHAW BOX"
Robbins & Meyers, Inc.—"R & M"
Joseph T. Ryerson & Son, Inc.
Shepard Niles Crane & Hoist Corp.
Yale & Towne Mfg. Co.

HOISTS, PORTABLE

Chicago Pneumatic Tool Co.
Coffing Hoist Div., Duff-Norton Co.
Denver Equipment Co.—"DENVER"
Flood City Brass & Electric Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"BUDGIT"
Harnischfeger Corp.
Ingersoll-Rand Co.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"BUDGIT," "TUG-IT," "SHAW BOX"
Mobile Drilling Inc.
The Oster Mfg. Co.
Robbins & Meyers, Inc.—"R & M"
Ruger Equipment, Inc.
Joseph T. Ryerson & Son, Inc.
Schroeder Brothers Corp.
Shepard Niles Crane & Hoist Corp.
Yale & Towne Mfg. Co.

HOISTS, SCRAPER

American Hoist & Derrick Co.—"AMERICAN"
Ingersoll-Rand Co.
Joy Mfg. Co.
Sauerman Bros., Inc.

HOISTS, SHAFT

Connellsville Mfg. & Mine Supply Co.
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div.—"SHAW-BOX"
Mayo Tunnel & Mine Equipment Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works

HOISTS, SKIP

Link-Belt Co., Dept. CAMGL-57

HOISTS, SLOPE

Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Morse Bros. Machinery Co.
Nordberg Mfg. Co.
Vulcan Iron Works

HOISTS, TRUCK-BODY

Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Marion Metal Products Co.
Perfection Steel Body Co.
Vickers, Inc., Tulsa Winch Div.

HOLDBACKS, CONVEYOR

Link-Belt Co., Dept. CAMGL-57
Stephens-Adamson Mfg. Co.

HOPPERS—See Bins & Hoppers, Storage & Blending

HOPPERS, WEIGH

Robert Holmes & Bros., Inc.
Industrial Physics & Electronics Co.
The Nolan Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.

HOSE ASSEMBLIES, SPLIT FLANGE

Anchor Coupling Co. Inc.

HOSE, AIR

Acme Machinery Co.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Chicago Pneumatic Tool Co.
Eimco Corp.
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"COMMANDER-TYPE 88," "TYPE 50-MAX-EGON ALL PURPOSE"
Goodyear Tire & Rubber Co.
Guyan Machinery Co.
Hamilton Rubber Mfg. Corp.—"REVELATION"
Hewitt-Robins Incorporated—"MONARCH," "AJAX," "HEWITT," "MALTESE CROSS"
Industrial Rubber Products Co. (Pa.)
Joy Mfg. Co.
Lincoln Engrg. Co.
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "STERLING CORD," "JUBILEE"
Olin-Mathieson Chemical Corp., Explosives Div.
Ore Reclamation Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TOWER"
Schroeder Brothers Corp.
Thermoid Co.
Thor Power Tool Co.
United States Rubber Co.
Victor Equipment Co.
Weatherhead Co., Fort Wayne Div.

HOSE, AIR-SHOOTING

Central Mine Supply Div.,
Pickard Industries, Inc.

HOSE, COAL WASHING

B. F. Goodrich Industrial Products Co.—"CONVERTAPIPE"

HOSE, CONDUIT

Guyan Machy. Co.

HOSE, FIRE

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"PINNACLE," "COMMANDER," "SOLAR," "MAINSTAY," "CASCADE," "B.F.G.," "SIGNAL"
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.—"UNDERWRITERS"
Hewitt-Robins Incorporated—"AJAX," "MONARCH," "MALTESE CROSS"
Industrial Rubber Products Co. (Pa.)
Mine Safety Appliances Co.
New York Belting & Packing Co.—"AFMIC," "DELTA CARBOLIZED," "DUNDEE"
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
United States Rubber Co.

HOSE, FLEXIBLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co.
Cobra Metal Hose, Div., DK Mfg. Co.
Compton, Inc.
Farris Flexible Valve Corp.—"FLEX VALVE"
Flexaust Co.—"FLEXAUST"
Franklin Plastics, Inc.—"DUR X PLASTIC"
Goodall Rubber Co.

Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (Pa.)
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "STERLING CORD," "JUBILEE," "INDESTRUCTIBLE"
R. W. Nichols Co.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, FLEXIBLE METAL

Cobra Metal Hose, Div., DK Mfg. Co.

HOSE, FLEXIBLE, MINE

Acme Machinery Co.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Eimco Corp.
Franklin Plastics, Inc.—"DUR X PLASTIC"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"WETER," "CONVERTAPIPE"
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (Pa.)
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "STERLING CORD," "JUBILEE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.

HOSE, GAS

Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

HOSE, GASOLINE

B. F. Goodrich Industrial Products Co.—"TYPES 72, 72-A, 72-W PUMP HOSE—TYPES 79 & 82-A TANK HOSE, TYPES 83 & 83-A FUEL OIL HOSE"

HOSE, GREASE & OIL

Boston Woven Hose & Rubber Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (Pa.)
Lincoln Engrg. Co.
New York Belting & Packing Co.—"GREAT SEAL," "MAGIC," "PARA," "PRESSURE FLEX"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Stewart-Warner Corp., Alemite Div.
Thermoid Co.
Weatherhead Co., Fort Wayne Div.

HOSE, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Blackhawk Mfg. Co.
Carlyle Rubber Co., Inc.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.—"EASTMAN"
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (Pa.)
Joy Mfg. Co.
Le-Hi Div., Hose Accessories Co.
Mining Machine Parts, Inc.
National Mine Service Co.
New York Belting & Packing Co. —"INDESTRUCTIBLE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"WIRETEX"
Schroeder Brothers Corp.
Stewart Warner Corp., Alemite Div.
Tamping Bag Co. Pickard Industries, Inc.—"SEAL-TITE"
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE, ROCK-DUST

American Mine Door Co.
B. F. Goodrich Industrial Products Co.—"DUSTEX"
Mine Safety Appliances Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.

HOSE, STEAM

Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

HOSE, SUCTION, DISCHARGE

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (Pa.)
New York Belting & Packing Co. —"STERLING," "CLIFTON," "DOUBLE DIAMOND," "OLD GOLD," "PARA"
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.
Thermoid Co.
United States Rubber Co.

HOSE, WATER

Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works—"VITALIC," "LIBERTY," "TRIBUNE," "ENDURO"
Flood City Brass & Electric Co.
Franklin Plastics, Inc.—"DUR X PLASTIC"
Gates Rubber Co.
Gering Products, Inc.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"JUPITER DELUGE ALARM"
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.—"STAPLE"
Hewitt-Robins Incorporated—"MONARCH," "AJAX," "HEWITT"
Industrial Rubber Products Co. (Pa.)
Lincoln Engrg. Co.
New York Belting & Packing Co.—"STERLING CORD," "MAGIC," "GREAT SEAL," "DOUBLE DIAMOND," "INDESTRUCTIBLE," "JUBILEE"
Ore Reclamation Co.
Plymouth Rubber Co. Inc.
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Republic Rubber Div., Lee Rubber & Tire Co.—"TONKA"
Thermoid Co.
United States Rubber Co.

HOSE FITTINGS

Aeroquip Corp.—"SOCKETLESS"
Anchor Coupling Co., Inc.
Boston Woven Hose & Rubber Co.
Carlyle Rubber Co., Inc.
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co.
Continental Rubber Works
Flood City Brass & Electric Co.
Gates Rubber Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Industrial Rubber Products Co. (Pa.)
Hewitt-Robins Incorporated
Le-Hi Div., Hose Accessories Co.
Lincoln Engrg. Co.
Mining Machine Parts, Inc.
New York Belting & Packing Co.
Schroeder Brothers Corp.
Standard Devices Co.
Victor Equipment Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS DETACHABLE & REUSABLE

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Continental Rubber Works
Goodall Rubber Co.
B. F. Goodrich Industrial Products. Co.
Goodyear Tire & Rubber Co.
C. B. Hunt & Son, Inc.—"QUIK-AS-WINK"
Industrial Rubber Products Co. (Pa.
Le-Hi Div., Hose Accessories Co.
Lincoln Engrg. Co.—"LOK-TITE"
Mining Machine Parts, Inc.
New York Belting & Packing Co.—"SINGLE STAR"
Schroeder Brothers Corp.
Standard Devices Co.
Thermoid Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, HYDRAULIC

Aeroquip Corp.
Anchor Coupling Co., Inc.
Carlyle Rubber Co., Inc.
Compton, Inc.
Continental Rubber Works
Goodall Rubber Co.
B. F. Goodrich Industrial Psoducts Co.
Goodyear Tire & Rubber Co.
Le-Hi Div., Hose Accessories Co.
Industrial Rubber Products Co. (Pa)
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
New York Belting & Packing Co.
Schroeder Brothers Corp.
Standard Devices Co.
Stewart Warner Corp.
Thermoid Co.
United States Rubber Co.
Weatherhead Co., Fort Wayne Div.

HOSE FITTINGS, SWAGED

Weatherhead Co., Fort Wayne Div.

HOSE & TUBE COMBINATIONS

Anchor Coupling Co. Inc.

HYDRAULIC ACCUMULATORS

Schroeder Brothers Corp.

HYDRAULIC CONTROL UNITS

Caterpillar Tractor Co.

HYDRAULIC CYLINDERS

Acme Machinery Co.
Blackhawk Mfg. Co.
Joy Mfg. Co.
Kalamazoo Div., New York Air Brake Co—"HYDRECO"

Ledeen Mfg. Co.
R. W. Nichols Co.
Schroeder Brothers Corp.
R. H. Sheppard Co., Inc.
Star Jack Co., Inc.
Vickers, Inc.
Wellman Engineering Co., McDowell Enterprise

HYDRAULIC CYLINDERS PUMPS, VALVES, REBUILT
Leman Machine Co.

HYDRAULIC FLUID
The American Oil Co.
Cities Service Oil Co.
Esso Standard Oil Co.
Keystone Lubricating Co.
Shell Oil Co.
Sun Oil Co.—"SOLNUS," "SUNTAC," "SUNVIS"

HYDRAULIC FLUIDS, FIRE-RESISTANT
Monsanto Chemical Co., Organic Chemicals Div.
Shell Oil Co.
Swan-Finch Petrochemicals

HYDRAULIC POWER UNITS
Schroeder Brothers Corp.

HYDRAULIC PUMPS
American Engineering Co.—"HELE-SHAW," "HYRAMITE"
Baughman Mfg. Co., Inc.
Blackhawk Mfg. Co.
Compton, Inc.
Denison Engineering Div, American Brake Shoe Co.
Gar Wood Industries, Inc.
Joy Mfg. Co.
Kalamazoo Div., New York Air Brake Co.—"HYDRECO"
R. W. Nichols Co.
Oliver Iron & Steel Corp.—"BERRY"
Schroeder Brothers Corp.
Star Jack Co., Inc.
Vickers, Inc.
Worthington Corp.

HYDRAULIC PUMPS, REBUILDING, REPAIR
Meckum Engr. Co.
Vickers, Inc.
West Virginia Armature Co.

HYDRAULIC STEERING GEARS
R. H. Sheppard Co., Inc.

HYDRAULIC VALVES
Blackhawk Mfg. Co.
A. W. Cash Co.
Denison Engineering Div., American Brake Shoe Co.
C. B. Hunt & Son, Inc.—"QUIK-AS-WINK"
Kalamazoo Div., New York Air Brake Co.—"HYDRECO"
Ledeen Mfg. Co.
Lunkenheimer Co.—"LUNKENHEIMER"
R. W. Nichols Co
R-P & C Valve Div., American Chain & Cable Co., Inc.
Schroeder Brothers Corp
Star Jack Co., Inc.
Vickers, Inc.
Walworth Co.

HYDROSEPARATORS
Bird Machine Co.
Denver Equipment Co.—"DENVER," "HYDRO-CLASSIFIER"
Dorr-Oliver, Inc.
Hardinge Co., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Western Machinery Co.—"WEMCO"

INDICATING LIGHTS
Cutler-Hammer, Inc.—"PRESTEST"

INDICATORS, DATA-DISPLAY AND TRANSFER
Union Switch & Signal Div. of Westinghouse Air Brake Co.

INDICATORS, REMOTE
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
B-I-F Industries, Inc.
The Bristol Co.
Femco, Inc.
Fischer & Porter Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Industrial Physics & Electronics Co.
Taller & Cooper

INDICATORS, SIGHT-FEED AND WATER
Lunkenheimer Co.—"LUNKENHEIMER"

INDICATORS, TEMPERATURE
West Instrument Corp.—"VERI-TELL"

INSTRUMENTS, BLASTING-VIBRATION
King Powder Co., Inc.
W. F. Sprengnether Instrument Co., Inc.
Taller & Cooper

INSTRUMENTS, FLOW-INDICATING
New Jersey Meter Co.—"FLOSIG," "TOOL-OM-ETER," "DRILL-OM-ETER"

INSTRUMENTS—HYDRAULIC CIRCUIT TESTING
Schroeder Brothers Corp.

INSTRUMENTS, RECORDING, PRESSURE TEMPERATURE, ETC.
B-I-F Industries, Inc.—"FLO-WATCH," "CHRONOFLO"
The Bristol Co.
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
Hays Corp.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Taller & Cooper
West Instrument Corp.—"MARKSMAN"
Westinghouse Electric Corp.

INSTRUMENTS, ROOF-CONTROL
Herold Mfg. Co.

INSULATING MATERIALS, ELECTRIC
Dow Corning Corp.
Duquesne Mine Supply Co.
General Electric Co., Chemical And Metallurgical Div., Insulating Materials Section—"IRRATHENE"
Graybar Elec. Co., Inc.
Irvington Div., Minnesota Mining & Mfg. Co.
Johns-Manville—"FIBROID," "ARMATURO," "QUINTERRA," "QUINTERRABORD" "QUINORGO," "QUINORGOBORD"
Keasbey & Mattison Co.
The Kerite Co.
Mica Insulator Co.—"LAMICOID," (Laminated Plastics, Sheets, Rods, Tubes); "ISOMICA," (Built-Up Mica Paper Products); "MICANITE," Built-Up Mica Splittings Products); "EMPIRE," (Coated Papers and Fabrics)
National Electric Coil Co.
Pennsylvania Electric Coil Corp.
Shell Oil Co.
Square D Co.
United States Rubber Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

INSULATING MATERIALS, HEAT & COLD
Bigelow-Liptak Corp.
Philip Carey Mfg. Co.—"CAREYCEL - ALL - TEMP - AIRCELL," "IMPERVO - PERFECTO-EXCEL"
Johns-Manville — "SUPER-EX," "ASBESTO-SPONGE," "THERMOBESTOS," "ROCK CORK," "ZERO-LITE," "FIBROCEL," "THERMOFLEX," "ASBESTOCEL," "SPINTEX"
Keasbey & Mattison Co.
Mexico Refractories Co.—"PLASTIC," "Vee-BLOCK CASTABLE," "M-5," "I-R-C"
Pittsburgh Corning Corp.—"FOAMGLAS"
Pittsburgh Plate Glass Co.—"PPG FIBER GLASS,"
Ruberoid Co.
United States Rubber Co.

INSULATING MATERIALS, NOISE
Johns-Manville — "SPIN-COUSTIC," "SINACOUSTIC," "PERMACOUSTIC," "FIBRETONE," "AIRACOUSTIC"
Keasbey & Mattison Co.—"SPRAYED LIMPET," "ASBESTOS"
Pittsburgh Plate Glass Co.—"PPG FIBRE GLASS"
United States Rubber Co.

INSULATORS, ELECTRIC
The Elreco Corp.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Ohio Brass Co.

INSULATORS, RUBBER
Continental Rubber Works

INSULATORS, SECTION
The Elreco Corp.—"ELRECO"

INSURANCE, CASUALTY, WORKMEN'S COMPENSATION
Bituminous Casualty Corp.
Eureka Casualty Co. (Fire Association Group)
J. B. Pfister Co.

INSURANCE, PLANT & EQUIPMENT
J. B. Pfister Co.

INSURANCE, SELF PROGRAMS
J. B. Pfister Co.

J-HOOKS, INSULATED
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"

J-HOOKS, NON-INSULATED
The Elreco Corp.—"ELRECO"

JACKLEGS, PNEUMATIC
Schroeder Brothers Corp.

JACK-PIPE
Duquesne Mine Supply Co.

JACKS, AIR-OPERATED
Acme Machinery Co.
Duff-Norton Co.
Joyce Cridland Co.
Templeton, Kenly & Co.—"REMO-TROL"

JACKS, BELT-TENSIONING
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, ELECTRICALLY OPERATED
Templeton, Kenly & Co.—"REMOTROL"

JACKS, GASOLINE-OPERATED
Templeton, Kenly & Co.—"REMOTROL"

JACKS, GEARED
Duff-Norton Co.
Joyce Cridland Co.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, HYDRAULIC
Blackhawk Mfg. Co.
Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
H. K. Porter, Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, PULLING
Armstrong, Bray & Co.

Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
The Nolan Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"JENNY"
Transall Inc.

JACKS, PUSH & PULL

Armstrong, Bray & Co.
Blackhawk Mfg. Co.
Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
H. K. Porter, Inc.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, RACHET LIFTING, LOWERING

Duff-Norton Co.
Joyce Cridland Co.
Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, ROOF

Duff-Norton Co.
Duquesne Mine Supply Co.
Herold Mfg. Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"
Vulcan Iron Works

JACKS, ROOF, HYDRAULIC

Penn Machine Co.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, SCREW

Duff-Norton Co.
Joyce Cridland Co.
Ensign Electric & Mfg. Co.
Gibraltar Equipment & Mfg. Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JACKS, TIMBERING

Duff-Norton Co.
Ensign Electric & Mfg. Co.
Herold Mfg. Co.
Mosebach Electric & Supply Co.
Penn Machine Co.
Star Jack Co., Inc.
Templeton, Kenly & Co.—"SIMPLEX"

JETS, OVERFIRE, SMOKE CONTROL

Canton Stoker Corp.—"TURBO-AIRE"

JIG SAWS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

JIGS, PYRITE RECOVERY

Denver Equipment Co.—"DENVER," "SELECTIVE MINERAL"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

JOINTS, SWIVEL

Chikson Co.

JOURNAL BOXES, REBUILT

Leman Machine Co.

JOURNALS, BOXES

American Car & Foundry Div., ACF Industries, Inc.
American Crucible Products Co.
C. S. Card Iron Works
Chain Belt Co.—"REX"
Enterprise Wheel & Car Corp.
Flood City Brass & Electric Co.
Helmick Foundry-Machine Co.
Hyatt Bearings Div., General Motors Corp.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburgh Mfg. Corp.
Ore Reclamation Co.
West Virginia Armature Co.

JUNCTION BOXES, ELECTRIC, STRIPPING

Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Joy Mfg. Co.

JUNCTION BOXES, ELECTRIC, UNDERGROUND

Albert & J. M. Anderson Mfg. Co.—"POW-R-GARD," "GROUND-GARD"
Crouse-Hinds Co.
Ensign Electric & Mfg. Co.
Graybar Elec. Co., Inc.
Joy Mfg. Co
National Electric Products Co.
Ohio Brass Co.
Schroeder Brothers Corp.

KNEE PADS

General Scientific Equipment Co.
Judsen Rubber Works, Inc.
Mine Safety Appliances Co.
National Mine Service Co.
Pulmosan Safety Equip. Co.
The Salem Tool Co.

KW, KWRA, KVA, RKVA METERS

The Bristol Co.—"BRISTOLS"
Graybar Elec. Co., Inc.
Westinghouse Electric Corp.

LABORATORY EQUIPMENT

Bausch & Lomb Optical Co.
Central Scientific Co.
Denver Equipment Co.-"DENVER"
Fisher Scientific Co.
Galigher Co.
General Scientific Equipment Co.
Robert Holmes & Bros., Inc.
Laboratory Equipment Corp.—"LECO"
Sturtevant Mill Co.
W. S. Tyler Co.

LABORATORY EQUIPMENT, COAL DRYING

Link-Belt Co., Dept. CAMGL-57

LABORATORY GLASSWARE

Fischer & Porter Co.—"LABCREST"

LABORATORY TESTING

Commercial Testing & Engineering Co.
Denver Equipment Co.—"DENVER"
Galigher Co.
Mobile Drilling Inc.
Sturtevant Mill Co.
Werner Laboratories
Western Machinery Co.—"WEMCO"

LACING, BELT

Armstrong-Bray & Co.
Flexible Steel Lacing Co.
General Splice Corp.—MINET"

LAMP GUARDS

McGill Mfg. Co., Inc.—"McGILL"

LAMPS, INCANDESCENT & MERCURY VAPOR

Radiant Lamp Corp.—"RADIANT"

LAMPS, PICKING

General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Mosebach Elec. & Supply Co.

LARRIES

Chain Belt Co.-"REX"
Connellsville Mfg. & Mine Supply Co.
Fairfield Engineering Co.
Irwin Foundry & Mine Car Co.
Link-Belt Co., Dept. CAMGL-57
Stephens-Adamson Mfg. Co.

LARRIES, WEIGH

Link-Belt Co., Dept. CAMGL-57

LATHES

Farrel-Birmingham Co., Inc.
The Oster Mfg. Co.—"RAPIDUCTION" (OSTER)
South Bend Lathe Works

LATEX

B. F. Goodrich Industrial Products Co.

LEADING WIRE

Hercules Powder Co.

LEADING WIRE, BLASTING

American Cyanamid Co., Explosives Dept.

LEVELS, ENGINEERS

C. L. Berger & Sons, Inc.—"BERGER"
Gibraltar Equipment & Mfg. Co.
Gurley, W. & L. E.
Kern Instruments, Inc.

LEVELS, TRACK

Aldon Co.

LIGHTING, EMERGENCY

American Optical Co.—"SENTRY-LITE"
Exide Industrial Div., Electric Storage Battery Co.—"EXIDE LIGHTGUARD"

LIGHTING FIXTURES

Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Ideal Industries, Inc.
Phoenix Metal Products, Metal Spinning Div.
Westinghouse Electric Corp.

LIGHTING FIXTURES, UNDERGROUND

Femco, Inc.
Graybar Elec. Co., Inc.
Ideal Industries, Inc.
Mine Safety Appliances Co.—"M-S-A FLUORESCENT"

LIGHTNING ARRESTERS

Delta-Star Electric Div., H. K. Porter Co. (Delaware)
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Ohio Brass Co.
Westinghouse Electric Corp.

LIGHTS, VAPOR-TIGHT, PORTABLE FLUORESCENT

Day-Ray Products, Inc.—"DAY-RAY"

LINER PLATE, CHUTES, CONVEYORS, ETC.

American Brake Shoe Co., Amsco Div.—"AMSCO"
Armco Drainage & Metal Prod., Inc.
Connellsville Mfg. & Mine Supply Co.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
McNally-Pittsburgh Mfg. Corp.
K. Prins & Associates

LINER PLATE, SHAFT & TUNNEL

Armco Drainage & Metal Prod., Inc.
Connellsville Mfg. & Mine Supply Co.
Republic Steel Corp.—"TRUSCON"

LININGS, CHUTE, CERAMIC

Bigelow-Liptak Corp.

LININGS, CHUTE, GLASS

Pittsburgh Plate Glass Co.—"CARRARA"

LININGS, CHUTE, METAL

American Brake Shoe Co., Amsco Div.—"AMSCO"

The Daniels Co., Contractors, Inc.
Illinois Zinc Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Laubenstein Mfg. Co.
Remaly Mfg. Co. Inc.
Stulz-Sickles Co.—"MANGANAL"

LININGS, CHUTE, PLASTIC
Insul-Mastic Corp. of America—"POLYPLY 5620"

LININGS, CHUTE, RUBBER
Boston Woven Hose & Rubber Co.
Galigher Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hamilton Rubber Mfg. Corp.—"ENDURANCE"
Industrial Rubber Products Co. (Pa.)
Linatex Corp. of America
Magic Chemical Co.—"MAGIC-VULCIRON RUBBER"
New York Belting & Packing Co.—"KARBONITE"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.
United States Rubber Co.

LININGS, CHUTE, RUBBER, PLAIN & METAL BACKED
B. F. Goodrich Industrial Products Co.

LININGS, CONCRETE
Bigelow-Liptak Corp.
Mayo Tunnel & Mine Equipment Co.
Sika Chemical Corp

LININGS, FURNACE
Bigelow-Liptak Corp.
Joseph Dixon Crucible Co.
Mexico Refractories Co.

LININGS, PNEUMATIC CONCRETE
Cement Gun Co., Inc.—"GUNITE"

LININGS, TANK
Cement Gun Co., Inc.—"GUNITE"

LININGS, TANK FLUOROCARBON
The Garlock Packing Co.

LININGS, TANK, GLASS
Pittsburgh Plate Glass Co.-"CARRARA & HERCULITE"

LININGS, TANK, METAL
Steelcote Mfg. Co.—"STEELCOTE ERO-LUX COATINGS"

LININGS, TANK, PLASTIC
Butler Mfg. Co.
Insul-Mastic Corp. of America—"POLY-PLY 5620"

LININGS, TANK, RUBBER
Continental Rubber Works
Denver Equipment Co.—"DENVER"
Galigher Co.
Gates Rubber Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Industrial Rubber Products Co. (Pa.)
Linatex Corp. of America
Magic Chemical Co.—"MAGIC-VULC"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.
United States Rubber Co.

LOAD BINDERS
Gibralter Equipment & Mfg. Co.

LOAD CONTROLLERS, ELECTRONIC
Cox & Stevens Electronic Sales Div.—"COX & STEVENS"

LOADERS, BUCKET
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"

LOADERS, PORTABLE, BELT, BUCKET, CHAIN
Barber-Greene Co.
Baughman Mfg. Co., Inc.
Bonded Scale & Machine Co.—"BONDED"
Gruendier Crusher & Pulverizer Co.
George Haiss Mfg. Co. Div., Pettibone Mulliken Corp.
Irwin Foundry & Mine Car Co.
Kremser & Sons, Inc., Frank A.
Lippmann Engrg. Works Inc.
Stephens-Adamson Mfg. Co.

LOADERS, SELF PROPELLED BELT
Athey Products Corp.

LOADERS, SHOVEL-TYPE, CRAWLER
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bay City Shovels, Inc.
J. I. Case Co.—"CASE TERRA-TRAC"
Caterpillar Tractor Co.—"TRAXCAVATOR. S"
Eimco Corp
Insley Mfg. Corp.
International Harvester Co., Construction Equipment Div.—"SKID-SHOVEL"
Koehring Co.
Link-Belt Speeder Corp.
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAX"
Sanford Day Iron Works, Inc.
Tractomotive Corp.—"TRAC-TO-SHOVEL"

LOADERS, SHOVEL-TYPE, RUBBER-TIRED
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
The Frank G. Hough Co.
Insley Mfg. Corp.
International Harvester Co., Construction Equipment Div.—"PAYLOADER"
Koehring Co.
Link-Belt Speeder Corp.
Tractomotive Corp.—"TRAC-TO-LOADER"

LOADERS, TRACTORS
J. I. Case Co.—"CASE-TERRA-TRAC"
Eimco Corp.
International Harvester Co., Construction Equipment Div.
Oliver Corp.
Pettibone Mulliken Co.
R. H. Sheppard Co., Inc.

LOADERS, TRACTOR-MOUNTED
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"
Eimco Corp.
Goodman Mfg. Co.
International Harvester Co., Construction Equipment Div.
Joy Mfg. Co.
Morse Bros. Machinery Co.

LOADERS, TRACTOR-MOUNTED REBUILT
Leman Machine Co.

LOADING BOOMS, APRON
Fairmont Machinery Co.
Helmick Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

LOADING BOOMS, BELT
Fairmont Machinery Co.
Helmich Foundry-Machine Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Webster Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

LOADING BOOMS, CHAIN
Fairmont Machinery Co.
Helmich Foundry-Machine Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Ore Reclamation Co.
K. Prins & Associates
Robert Holmes & Bros., Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Webster Mfg. Co.
Wellman Engineering Co., McDowell Enterprise

LOADING BOOMS, CHAIN RESCREENING
Fairmont Machinery Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

LOADING-MACHINE CHECKS
The Daly Ticket Co.—"DALY'S"

LOADING MACHINES, REBUILT
Leman Machine Co.

LOADING MACHINES, UNDERGROUND, CRAWLER
Eimco Corp.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Speeder Corp.—"EXCALODER"
The Long Co.
Morse Bros. Machinery Co.
Myers-Whaley Co.—"WHALEY AUTOMAX"
Sanford Day Iron Works, Inc.

LOADING MACHINES, UNDERGROUND, RUBBER-TIRED
Jeffrey Mfg. Co.
National Mine Service Co.—"CLARKSON"

LOADING MACHINES, UNDERGROUND, CONVERTED TRACK TO RUBBER
Lee-Norse Co.

LOADING MACHINE UNDERGROUND, TRACK-MOUNTED
Eimco Corp.
Gardner-Denver Company
Goodman Mfg. Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Myers-Whaley Co.—"WHALEY AUTOMAX"

LOCKERS
The Moore Co.
Republic Steel Corp.—"REPUBLIC STEEL"

LOCK NUTS
Bearings, Inc.
Elastic Stop Nut Corp. of America—"ELASTIC STOP NUTS"
Link-Belt Co., Dept. CAMGL-57
National Electric Products Co.
The Palnut Co. Sub. United-Carr Fastener Corp.—"PALNUT"

Republic Steel Corp.—"REPUBLIC NYLOK"

LOCOMOTIVES, AIR

Elmco Corp.

LOCOMOTIVES, BATTERY

General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
Greensburg Machine Co.
Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Kersey Manufacturing Co., Inc.
Morse Bros. Machinery Co.

LOCOMOTIVES, CABLE-REEL

General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
Jeffrey Mfg. Co.
National Mine Service Co.
West Virginia Armature Co.

LOCOMOTIVES, DIESEL HYDRAULIC

General Electric Co., Locomotive & Car Equipment Dept.

LOCOMOTIVES, DIESEL, SURFACE

Brookville Locomotive Works
Diesel Energy Corp.
Greensburg Machine Co.
Plymouth Automotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH TORQOMOTIVE"
Vulcan Iron Works

LOCOMOTIVE, DIESEL, UNDERGROUND

Brookville Locomotive Works
Goodman Mfg. Co.
Greensburg Machine Co.
Mayo Tunnel & Mine Equipment Co.
National Mine Service Co.
Plymouth Automotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH MINE-O-MOTIVE"

LOCOMOTIVES, DIESEL-ELECTRIC

Diesel Energy Corp.
Differential Steel Car Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.
Vulcan Iron Works

LOCOMOTIVES, GASOLINE, SURFACE

Plymouth Locomotive Works, Div. of The Fate-Root-Heath Co.—"PLYMOUTH TORQOMOTIVE"

LOCOMOTIVES, REBUILT

Leman Machine Co.

LOCOMOTIVES, TROLLEY

Differential Steel Car Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Locomotive & Car Equipment Dept.
Goodman Mfg. Co.
Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Morse Bros. Machinery Co.
National Mine Service Co.
West Virginia Armature Co.

LUBRICANTS

Alpha Molykote Corp.—"MOLYKOTE"
The American Oil Co.
Ashland Oil & Refining Co.—"ASHLAND"
Bearings, Inc.—"LUBRIKO"
The Brooks Oil Co.—"LEADOLENE," "KLINGFAST," "BARCOTE"
Samuel Cabot, Inc.—"CABOT'S TASGON," "CABOT'S LUBRI-TASGON"
Cities Service Oil Co.
D-A Lubricant Co., Inc.—"D-A"
Joseph Dixon Crucible Co.
Dow Corning Corp.
Esso Standard Oil Co.
Gulf Oil Corp.
Hulburt Oil & Grease Co.
Jesco Lubricants Co.
Jet-Lube, Inc.
Keystone Lubricating Co.
New York & New Jersey Lubricant Co.—"NON-FLUID OILS"
Ohio Oil Co.
Pennsylvania Refining Co.
Pure Oil Co.—"POCO PB"
Shell Oil Co.
Standard Oil Co. (Ind.)
Stewart-Warner Corp., Alemite Div.
Sun Oil Co.—"SOLNUS," "SUNTAC," "SUNVIS"
Swan-Finch Petrochemicals—"AEROSOL"
The Texas Co.
Tidewater Oil Co.
Valvoline Oil Co., Div. Ashland Oil & Refining Co.
Warren Refining & Chemical Co.—"PLASTILUBE," "BUSTRUX," "PLASTIGEAR," "GREENGOLD," "WARCO," "STAY SIN," "THERMAX," "LITHOLUBE"
The Whitmore Mfg. Co.

LUBRICANTS, ROCK DRILL

Sun Oil Co.

LUBRICANTS, THREADING & CUTTING

The Oster Mfg. Co.—"BEST-OIL" (OSTER)

LUBRICATING FITTINGS

Gray & Co., Inc.
Guyan Machy. Co.
Lincoln Engrg. Co.—"BULL-NECK"
Stewart-Warner Corp., Alemite Div.

LUBRICATING GUNS

Joseph Dixon Crucible Co.
Gray & Co., Inc.
Guyan Machy. Co.
Lincoln Engrg.—"LUBRIGUNS"
Schroeder Brothers Corp.
Stewart-Warner Corp., Alemite Div.

LUBRICATING SYSTEMS, AUTOMATIC

Farval Corp.
Gray & Co., Inc.
Lincoln Engrg. Co.—"MULTI-LUBER"
Manzel Div., Houdaille Industries, Inc.
Nathan Mfg. Corp.—"NATHAN," "A," "P"
Stewart-Warner Corp., Alemite Div.
Trabon Engr. Corp.
Trico Fuse Mfg. Co.—"TRICO"

LUBRICATING SYSTEMS, CENTRALIZED

Farval Corp.
Lincoln Engrg. Co.—"CENTRO-MATIC"
Manzel Div., Houdaille Industries, Inc.
Nathan Mfg. Corp.—"NATHAN," "A," "P"
Stewart-Warner Corp., Alemite Div.
Trabon Engr. Corp.
Trico Fuse Mfg. Co.—"TRICO"

LUBRICATING SYSTEMS, MANUAL

Farval Corp.

LUBRICATING SYSTEMS, SPRAY, MANUAL, AUTOMATIC

Farval Corp.

LUBRICATORS

Lunkenheimer Co.—"BANNER," "MAJOR," "INDEPENDENT," "PARAGON," "PENLO, "PREMIER," "SENIOR"

LUBRICATORS, FLANGE

Transall Inc.

LUBRICATORS, JOURNAL-BEARING

American Brake Shoe Co., Railroad Products Div.

LUBRICATORS, RAIL

American Brake Shoe Co., Railroad Products Div.

LUBRICATORS, TROLLEY-WIRE

Ohio Brass Co.

LUMBER, TREATED, UNTREATED

T. J. Moss Tie Co.

LUMBER & TIMBER

Republic Creosoting Co.

MACHINE & MOTOR MOUNTS

Dayton Rubber Co.

MACHINE GUARDS, PARTS FOR

Helmick Foundry-Machine Co.
Hendrick Mfg. Co.

MACHINES, CUSTOM-BUILT

National Mine Service Co. (Clarkson Div.)—"CLARKSON"

MAGNETS, PERMANENT NONELECTRIC

Crucible Steel Co. of America

MAGNETS, PLATE TYPE

Dings Magnetic Separator Co.

MAGNETS, SEPARATING

Square D Co.

MAGNIFIERS

Bausch & Lomb Optical Co.

MAGNET WIRE

Crucible Steel Co. of America
Graybar Elec. Co., Inc.
Rome Cable Corp.

MAGNETIC SEPARATORS

Eriez Mfg. Co.

MAGNETIZING BLOCKS

Dings Magnetic Separator Co.

MAGNETITE

The Daniels Co., Contractors, Inc.
Orefraction, Inc.

MAGNETITE RECOVERY DENSIFIERS

Colorado Iron Works Co., A Sub. of Mine & Smelter Supply Co.—"AKINS"
Western Machinery Co.—"WEMCO"

MAGNETITE RECOVERY SEPARATORS

The Daniels Co., Contractors, Inc.
Dings Magnetic Separator Co.
Eriez Manufacturing Co.
Jeffrey Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products

MAGNETS, CHUTE-TYPE

Dings Magnetic Separator Co.
Eriez Manufacturing Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products
Sprout, Waldron & Co., Inc.

MAGNETS, PERMANENT NONELECTRIC, CHUTE, PULLEY, SUSPENDED

Dings Magnetic Separator Co.
Eriez Manufacturing Co.
Homer Mfg. Co.—"HOMER"
Magnetic Engrg. & Mfg. Co.
W. J. Savage Co.
Stearns Magnetic Products
Transall Inc.

MAGNETS, PULLEY-TYPE

Continental Gin Co.
Dings Magnetic Separator Co.
Eriez Manufacturing Co.
Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products

MAGNETS, SUSPENDED

Dings Magnetic Separator Co.
Eriez Manufacturing Co.

Magnetic Engrg. & Mfg. Co.
Stearns Magnetic Products

MALLETS, RUBBER
Goodyear Tire & Rubber Co.

MAPS
Jack Ammann Photogrammetric Engineers, Inc.

MAPS, TOPOGRAPHIC, PHOTOGRAPHIC
Aerial Surveys, Inc.
Aero Service Corp.
American Air Surveys, Inc.

MASKS, DUST
Martindale Electric Co.

METALLIZING EQUIPMENT
Wall Colmonoy Corp.—"SPRAY WELDER"

METALLIZING WIRE
Crucible Steel Co. of America

METERS, COMPRESSED-AIR
New Jersey Meter Co.—"TOOL-OM-ETER," "DRILL-OM-ETER"

METERS
Analytical Measurements, Inc.

METERS ELECTRICAL—See AMMETERS, ETC.

MICA MAT
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

MICA, PASTED
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

MICROSCOPES
Bausch & Lomb Optical Co.
Fisher Scientific Co.

MILLING MACHINES
Farrel-Birmingham Co., Inc.
South Bend Lathe Works

MILLISECOND CONNECTORS, DETONATING FUSE
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
King Powder Co., Inc.
Olin-Mathieson Chemical Corp., Explosives Div.

MILLS, BOWL, IMPACT, SCREEN, VERTICAL
Combustion Engineering, Inc.—"C-E-RAYMOND"

MILLS, LABORATORY
American Pulverizer Co.
Central Scientific Co.
Combustion Engineering, Inc.—"C-E-RAYMOND"
Denver Equipment Co.—"DENVER"
Fisher Scientific Co.
Sturtevant Mill Co.

MINE TIES, PRESSURE-CREOSOTED
Koppers Co., Inc., Wood Preserving Div.

MINE TIES, PRESSURE-TREATED
Koppers Co., Inc., Wood Preserving Div.—"WOLMANIZED"

MOILS
Cleco Div., Reed Roller Bit Co.
Howells Mining Drill Co.

MOISTURE-BARRIER PAPER
Fulton Bag & Cotton Mills

MOISTURE METERS
The Bristol Co.—"THERMO-HUMIDIGRAPH"
General Electric Co., Apparatus Sales Div.
Heyl & Patterson, Inc.—"OLIVO"
Industrial Physics & Electronics Co.
Viking Machinery Sales Corp.

MORTAR, REFRACTORY
Babcock & Wilcox Co.
Johns-Manville—"SIL-O-CEL"
Mexico Refractories Co.—"LO-SET," "MEX-LOX," "MILL MORTAR"
Norton Co.

MOTOR CONTROL CENTERS
Cutler-Hammer, Inc.—"UNITROL"

MOTOR CONTROLLERS, STARTERS
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Arrow Hart & Hegeman Electric Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Electric Machinery Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.
Ohio Brass Co.
W. J. Savage Co.
Schroeder Bros.
Square D Co.
Westinghouse Electric Corp.

MOTOR-GENERATOR SETS
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Louis Allis Co.
Century Electric Co.
The Electric Products Co.
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Hobart Bros. Co.
Joy Mfg. Co.
Leland Electric Co., Div. American Machine & Foundry Co.—"LELAND"
Lincoln Electric Co.—"SHIELD-ARC"
Master Electric Co.
Morse Bros. Machinery Co.
Reliance Elec. & Eng. Co.
Robbins & Meyers, Inc.—"R & M"
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Westinghouse Electric Corp.

MOTOR REWINDING, REDESIGN & REPAIRS
National Electric Coil Co.

MOTOR REWINDING, REPAIRS
Flood City Brass & Electric Co.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.
Pennsylvania Electric Coil Corp.
Scranton Electric Construction Co.
West Virginia Armature Co.
Westinghouse Electric Corp.

MOTORS, AC
Acme Machinery Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Louis Allis Co.
Bonded Scale & Machine Co.
Century Electric Co.
J. D. Christian Engineers
Diehl Manufacturing Co.
Dooley Brothers
Electric Machinery Mfg. Co.
Electric Products Co.
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.
Leland Electric Co., Div. American Machine & Foundry Co.—"LELAND"
Lincoln Electric Co.—"LINC-WELD"
Master Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Reliance Elec. & Eng. Co.
Robbins & Meyers, Inc.—"R & M"
W. J. Savage Co.
Schroeder Brothers Corp.
A. O. Smith Corp.
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
U. S. Electrical Motors, Inc.—"UNICLOSED VARIDRIVE SYNCROGEAR"
Wagner Electric Corp.
Westinghouse Electric Corp.

MOTORS, AIR
Acme Machinery Co.
Chicago Pneumatic Tool Co.
Elmco Corp.
Gardner-Denver Company
Joy Mfg. Co.—"TURBINAIR PISTONAIR"
Ingersoll-Rand Co.
R. W. Nichols Co.—"TORK-MOR"
Schroeder Brothers Corp.

MOTORS, DC
Acme Machinery Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Louis Allis Co.
Century Electric Co.
J. D. Christian Engineers
Diehl Manufacturing Co.
Dooley Brothers
Electro Dynamics Div., General Dynamics
Elliott Co.
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
F. R. Hannon & Sons—"HANCO"
Joy Mfg. Co.
Leland Electric Co., Div. American Machine & Foundry Co.—"LELAND"
Master Electric Co.
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
Reliance Elec. & Eng. Co.
Robbins & Meyers, Inc.—"R & M"
W. J. Savage Co.
Schroeder Brothers Corp.
A. O. Smith Corp.
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co.
Westinghouse Electric Corp.

MOTORS, FLUID
Link-Belt Co., Dept. CAMGL-57—"ELECTROFLUID"
Master Electric Co.
R. W. Nichols Co.—"TORK-MOR"
Oliver Iron & Steel Corp.—"BERRY"
Schroeder Brothers Corp.
Vickers Inc.

NAILS
American Steel & Wire

NEWSLETTERS, FOREMEN
Elliott Service Co., Inc.—"MANAGEMENT INFORMATION"

NIBBLERS, PORTABLE ELECTRIC
Black & Decker Mfg. Co.

NICKEL & NICKEL ALLOYS
International Nickel Co., Inc.

NOZZLES, AIR, BRONZE
Lunkenheimer Co.—"LUNKENHEIMER"

NOZZLES, BLASTING
Norton Co.—"NORBIDE"
Victor Equipment Co.

NOZZLES, FOG
Blaw-Knox Co.
Bete Fog Nozzle, Inc.

Carlyle Rubber Co., Inc.
Fyr-Fyter Div.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
S. P. Kinney Engineers, Inc.

NOZZLES, SPRAY

Bete Fog Nozzle, Inc.
Blaw-Knox Co.
The Branford Co.—"BRANFORD"

Carlyle Rubber Co., Inc.
Chain Belt Co.—"REX"
The Deister Concentrator Co.—"CONCENCO"
Deister Machine Co.
The Duriron Co., Inc.
Fyr-Fyter Div.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Johnson-March Corp.
S. P. Kinney Engineers, Inc.
Link-Belt Co., Dept. CAMGL-57
Viking Machinery Sales Corp.
West Virginia Armature Co.
Worthington Corp.

NOZZLES, WET ROCK DUSTING

American Mine Door Co.
Mine Safety Appliances Co.

NUTS

Bethlehem Steel Co.
Guyan Machy. Co.
Oliver Iron & Steel Corp.
The Palnut Co., Sub. United-Carr Fastener Corp.—"PALNUT"
Republic Steel Corp.—"REPUBLIC"
St. Louis Screw & Bolt Co.
Sheffield Div., Armco Steel Corp.
Tamping Bag Co. Div., Pickard Industries, Inc.—"SPECIAL-SAFETY"

NUTS, MINE ROOF BOLTS

The Palnut Co., Sub. United-Carr Fastener Corp.—"PALNUT"

OHMMETERS, MEGOHMMETERS

The Bristol Co.—"DYNA-MASTER"
General Electric Co., Apparatus Sales Div.
Martindale Electric Co.
Westinghouse Electric Corp.

OILS HYDRAULIC—SEE HYDRAULIC FLUIDS

OIL SEPARATORS

Bulkley, Dunton Processes, Inc.

OILS

Fiske Bros. Refining Co.—"LUBRIPLATE"
Pennsylvania Refining Co.—"SERIES 3," "H. D."
Pure Oil Co.—"PUROPALE RX" "SULTANA X HEAVY DUTY"
Swan-Finch Petrochemicals

OILS, AIR TOOL

New York & New Jersey Lubricant Co.

OILS, COMPRESSOR

Sun Oil Co.—"SOLNUS"

OILS, PENETRATING

Swan-Finch Petrochemicals—"AEROSOL"

OVERCASTS, CORRUGATED STEEL ROUND

Armco Drainage & Metal Prod., Inc.

OXYGEN-ADMINISTERING EQUIPMENT

General Scientific Equipment Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
Mine Safety Appliances Co.—"DEMAND PNEOPHORE," "PNEOLATOR," "PNEOPHORE," "PULMONARY VENTLATOR"
Victor Equipment Co.

PACKERS

Spang & Co.

PACKING

Anchor Packing Co.
Boston Woven Hose & Rubber Co.
The Garlock Packing Co.
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Greene, Tweed & Co.
Guyan Machy. Co.—"J-M"
Industrial Rubber Products Co. (Pa.)
Industrial Rubber Products Co. (W. Va.)
Hewitt-Robins Incorporated
Johns-Manville—"CENTRIPAC," "CHEMPAC," "JEWETT," "KEARSARGE," "MOGUL, "NAVALON, "SEA RINGS," "SERVICE," "SEIGELITE," "MOBILENE," "UNEEPAC," "CUMPAC"
New York Belting & Packing Co.—"GREAT SEAL," "N Y B & P," "INDESTRUCTABLE," "COBBS," "FIRO"
Quaker Rubber Div., H. K. Porter Co., Inc.
Raybestos Manhattan, Inc., Manhattan Rubber Div.—"R/M"
Republic Rubber Div., Lee Rubber & Tire Co.

PACKING, HYDRAULIC

Flood City Brass & Electric Co.

PACKING, RUBBER

United States Rubber Co.

PACKING EQUIP., BAG

Bemis Bro. Bag Co.

PAINTS

Samuel Cabot, Inc.—"CABOT'S FLEXIBLAC," "CABOT'S SCOLLOPAKES," "HOUSE & TRIM"
Philip Carey Mfg. Co.
Jospeh Dixon Crucible Co.
Magic Chemical Co.—"MAGIC-VULC"
E. I. du Pont de Nemours & Co., Inc.—"DUCO," "DULUX"
Pittsburgh Plate Glass Co.—"PITTSBURGH"
Rust-Oleum Corp.
Sika Chemical Corp.
Steelcote Mfg. Co.—"STEELCOTE ANTI-CORROSIVE"
United States Rubber Co.
Wilbur & Williams Co.

PAINTS, ALUMINUM

Joseph Dixon Crucible Co.
E. I. du Pont de Nemours & Co., Inc.
Insul-Mastic Corp. of America
Magic Chemical Co.—"MAGIC-VULC"
Master Bronze Powder Co.—"BROMA"
Pittsburgh Plate Glass Co.—"PITTSBURGH"
Rust-Oleum Corp.
Steelcote Mfg. Co.—"STEELCOTE SILICONE ALUMINUM"
Wilbur & Williams Co.—"TOTALUME"

PAINTS, DAMP SURFACES

Wilbur & Williams Co.—"DAMPCOAT"

PAINTS, ELECTRIC INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

PAINTS, INDUSTRIAL

Guyan Machy. Co.

PAINTS, REFLECTIVE

E. I. du Pont de Nemours & Co., Inc.
Insul-Mastic Corp. of America
Pittsburgh Plate Glass Co.—"PITTSBURGH"

PAINTS, SPRAY, ALKYD ENAMEL

Master Bronze Powder Co., Inc.—"BROMA SPRAY IT YOURSELF"

PANELBOARDS

The Bristol Co.—"BRISTOL'S"
Clark Controller Co.—"AMERICAN"
Crouse-Hinds Co.
The Daniels Co., Contractors, Inc.
General Electric Co., Distribution Assemblies Dept.
Graybar Elec. Co., Inc.
Hays Corp.
I-T-E Circuit Breaker Co.
Johns-Manville—"ASBESTOS EBONY," "OHMSTONE"
Square D Co.
Westinghouse Electric Corp.

PANELS, INSTRUMENT

The Bristol Co.—"BRISTOL'S"
Fischer & Porter Co.
Foxboro Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
Stewart-Warner Corp., Alemite Div.
Westinghouse Electric Corp.

PAPER, ELECTRIC INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

PARTS, DRILLING MACHINES

Kensington Steel, Div. of Poor & Co.
Mobile Drilling Inc.
Stardrill-Keystone Co. — "KEYSTONE," "STAR"

PARTS, LOCOMOTIVE

Flood City Brass & Electric Co.
Ironton Engine Co.—"IRONTON"
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Nathan Mfg. Corp.
National Mine Service Co.
Penn Machine Co.
Pittsburgh Gear Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, MINING MACHINERY

American Brake Shoe Co., Amsco Div.—"AMSCO"
Eimco Corp.
Flood City Brass & Electric Co.
Guyan Machy. Co.
Howells Mining Drill Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kelly Mfg. Co.—"KEMCO"
Kensington Steel, Div. of Poor & Co.
Marathon Coal Bit Co., Inc.—"MARATHON," "TRACY"
Mining Machine Parts Inc.
Mosebach Electric & Supply Co.
National Mine Service Co.
Penn Machine Co.
Pittsburgh Gear Co.
Taylor-Wharton Co., Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, MOTOR, ELECTRICAL

Flood City Brass & Electric Co.
Graybar Elec. Co., Inc.
Jeffrey Mfg. Co.
Reliance Elec. & Eng. Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, PULVERIZER, MANGANESE

Kensington Steel, Div. of Poor & Co.

PARTS, SHUTTLE CAR

Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Kelly Mfg. Co.—"KEMCO"
National Mine Service Co.
Penn Machine Co.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
West Virginia Armature Co.

PARTS, TRUCK

C. S. Card Iron Works

Dart Truck Co.
Hendrickson Mfg. Co.

PENTAPRISMS, (RIGHT-ANGLE)
Kern Instruments, Inc.

PH INDICATORS
Analytical Measurements, Inc.
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
Industrial Physics & Electronics Co.
Minneapolis-Honeywell Regulator Co., Industrial Div.
Westinghouse Electric Corp.

PHOTOCOPY EQUIPMENT, MATERIALS
Peerless Photo Products, Inc.

PHOTOGEOLOGY
E. J. Longyear Co.

PICKING TABLES
Bonded Scale & Machine Co.—"BONDED"
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kremser & Sons, Inc., Frank A.
Link-Belt Co., Dept. CAMGL-57
E. F. Marsh Engrg. Co.—"MARCO"
Morse Bros. Machinery Co.
Ore Reclamation Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
Syntron Co.
Wilmot Engineering Co.

PICKS
Bowdil Co.
Gibraltar Equipment & Mfg. Co.

PILING
Republic Creosoting Co.

PILINGS, LIGHTWEIGHT STEEL SHEET
L. B. Foster Co.

PILING, TREATED, UNTREATED
T. J. Moss Tie Co.

PILLOW BLOCKS, ANTIFRICTION-BEARING
Ahlberg Bearing Co.—"AHLBERG"
Bearings, Inc.
Chain Belt Co.—"SHAFER"
Continental Gin Co.
Dodge Mfg. Corp.—"SC-SCM-SLP," "DODGE-TIMKEN," "SPHER-ALIGN"
The Fafnir Bearing Co.
Guyan Machy. Co.—"SEAL-MASTER"
Hewitt-Robins Incorporated—"JONES"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57—"LINK-BELT" "JPS," "MILLBEARING"
SKF Industries, Inc.
Stephens-Adamson Mfg. Co.—"SEALMASTER"
Transall Inc.
Wilmot Engineering Co.

PILLOW BLOCKS, SLEEVE-BEARING
Bearings, Inc.
Chain Belt Co.—"REX"
Continental Gin Co.
Dodge Mfg. Corp.—"SLEE-VOIL"
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
K. Prins & Associates
Transall, Inc.
Wilmot Engineering Co.

PIPE, ALLOY STEEL
L. B. Foster Co.

PIPE, ALUMINUM
Aluminum Company of America—"ALCLAD"
L. B. Foster Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co
Revere Copper & Brass Inc.
Reynolds Metals Co.

PIPE, ASBESTOS-CEMENT
Johns-Manville—"TRANSITE"
Keasbey & Mattison Co.

PIPE, BRONZE
Ampco Metal, Inc.
Goyne Pump Co.

PIPE, CAST-IRON
Goyne Pump Co.
Graybar Elec. Co., Inc.
United States Pipe & Foundry Co.
Wilmot Engineering Co.

PIPE, CEMENT-LINED
Goyne Pump Co.
Jones & Laughlin Steel Corp.
United States Pipe & Foundry Co.

PIPE, COPPER, RED BRASS
Phelps Dodge Copper Products Co.
Revere Copper & Brass Inc.
Triangle Conduit & Cable Co., Inc.

PIPE, CORROSION-RESISTANT
Duriron Co., Inc.

PIPE, CORRUGATED
Armco Drainage & Metal Prod., Inc.
Republic Steel Corp.—"REPUBLIC"

PIPE, DRIVE, AND DRIVING WINCHES
Acker Drill Co. Inc.

PIPE, GLASS
Fisher Scientific Co.

PIPE, IRRIGATION, ALUMINUM
Aluminum Company of America
Reynolds Metals Co.

PIPE, PLASTIC
Carlon Products Corp.
Crane Co.
L. B. Foster Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL," "RIGID"
Graybar Elec. Co., Inc.
Guyan Machy. Co.—"SKY-LINE"
Hamilton Rubber Mfg. Corp.—"POLYETHYLENE"
Industrial Rubber Products Co. (Pa.)
Johnson Plastics Corp.
Midland Pipe & Supply Co.
National Mine Service Co.
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Plastex Co.—"PLASTEX MEASUREMARKED," "TROJAN"
Quaker Rubber Div., H. H. Porter Co., Inc.
Republic Steel Corp.—"REPUBLIC"
Triangle Conduit Cable Co., Inc.
United States Rubber Co.
Yardley Plastics Co.—"CLEARSTREAM"
Youngstown Sheet & Tube Co.—"FIBERCAST"

PIPE, PLASTIC, FLEXIBLE
Irvington Div., Minnesota Mining & Mfg. Co.

PIPE, RUBBER
Goodall Rubber Co.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
Industrial Rubber Products Co. (Pa.)
Linatex Corp. of America
New York Belting & Packing Co.—"INDESTRUCTABLE"
Raybestos Manhattan, Inc. Manhattan Rubber Div.—"CONDOR"
United States Rubber Co.

PIPE RUBBER-LINED
Farris Flexible Valve Corp.—"FLEXVALVE"
Galigher Co.
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Goodyear Tire & Rubber Co.
Industrial Rubber Products Co. (Pa.
Naylor Pipe Co.
New York Belting & Packing Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.
United States Rubber Co.

PIPE, SEAMLESS
Phoenix Iron & Steel Co.

PIPE, SLUDGE
Farris Flexible Valve Corp.—"FLEXVALVE"
Naylor Pipe Co.

PIPE, SPIRAL-WELDED
Armco Drainage & Metal Prod., Inc.
L. B. Foster Co.
Midland Pipe & Supply Co.
Naylor Pipe Co.

PIPE, STAINLESS STEEL
Allegheny Ludlum Steel Corp.
Crucible Steel Co. of America
National Tube Div., United States Steel Corp.—"USS"

PIPE, STEEL
Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
L. B. Foster Co.
Graybar Elec. Co., Inc.
Jones & Laughlin Steel Corp.
L. O. Koven & Bro., Inc.
Midland Pipe & Supply Co.
National Supply Company—"SPANG"
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Wheeling Steel Corp.
Youngstown Sheet & Tube Co.—"YOLOY"

PIPE, STEEL WELDED
Armco Drainage & Metal Prod., Inc.
Bethlehem Steel Co.
L. B. Foster Co.
Jones & Laughlin Steel Corp.
L. O. Koven & Bro., Inc.
The R. C. Mahon Co.
National Tube Div., United States Steel Corp.—"USS NATIONAL"
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Youngstown Sheet & Tube Co.

PIPE, WOOD
Peter O. Sutphen

PIPE, WOOD-LINED
Goyne Pump Co.
Peter O. Sutphen

PIPE, WOOD-STAVE
Peter O. Sutphen

PIPE, WROUGHT-IRON
A. M. Byers Co.
Midland Pipe & Supply Co.
Wilmot Engineering Co.

PIPE COUPLINGS
Dresser Mfg. Div., Dresser Industries, Inc.

PIPE COUPLINGS, FLEXIBLE
Victualic Co. of America—"VICTUALIC"

PIPE COVERINGS
Philip Carey Mfg. Co.—"CARE-

YCLE-ALL-TEMP-AIRCELL," "IMPERVO-PERFECTO EXCEL"
Galigher Co.
Gustin-Bacon Mfg. Co.—"SNAP-ON"
Johns-Manville — "TRANTEX-TAPE," "TRANSHIELD-FELT"
The Ruberoid Co.

PIPE FABRICATION
Dravo Corp.
The Stearns-Roger Mfg. Co.

PIPE FITTINGS
Anchor Coupling Co., Inc.
Armco Drainage & Metal Prod., Inc.
Crane Co.
Dresser Mfg. Div., Dresser Industries, Inc.
The Fairbanks Co.—"DART"
Goyne Pump Co.
Grinnell Co., Inc.
Gustin-Bacon Mfg. Co.—"GRUVAGRIP"
Guyan Machy. Co—"GRINNEL," "VICTAULIC"
Midland Pipe & Supply Co.
Naylor Pipe Co.
R. W. Nichols Co.—"DEUTSCH"
United States Pipe & Foundry Co.
Victaulic Co. of America
Walworth Co.
Weatherhead Co., Fort Wayne Div.

PIPE FITTINGS, BRONZE
Ampco Metal, Inc.
Goyne Pump Co.
Grinnell Co., Inc.
Walworth Co.

PIPE FITTINGS, FLANGES-PLASTIC & WELDED
Midland Pipe & Supply Co.
United States Rubber Co.
Walworth Co.

PIPE FITTINGS, FLANGES, WELDED & SCREW
Grinnell Co., Inc.

PIPE FITTINGS, FORGED STEEL
Ladish Co.

PIPE FITTINGS, NYLON
Johnson Plastics Corp.

PIPE FITTINGS, PLASTIC
Carlon Products Corp.
Franklin Plastics Inc.—"DURX"
B. F. Goodrich Industrial Products Co.—"KOROSEAL," "RIGID," PLASTISOL"
Grinnell Co., Inc.
Johnson Plastics Corp.
Midland Pipe & Supply Co.
National Mine Service Co.
Plastex Co.
Republic Steel Corp.—"REPUBLIC"
Triangle Conduit & Cable Co., Inc.
United States Rubber Co.
Walworth Co.
Youngstown Sheet & Tube Co.

PIPE FITTINGS, RUBBER
United States Rubber Co.

PIPE FITTINGS, STAINLESS-STEEL
Electric Steel Foundry Co.

PIPE FITTINGS, STEEL & ALLOYS
Ladish Co.

PIPE FITTINGS, WELDING
Tube Turns, Div. National Cylinder Gas Co.—"TUBE-TURN"

PIPE HANGERS
Grinnell Co., Inc.

PIPE-REPAIR CLAMPS, SLEEVES
Dresser Mfg. Div., Dresser Industries, Inc.

PIPE TOOLS
Beaver Pipe Tools, Inc.
Graybar Elec. Co., Inc.
The Oster Mfg. Co.
Toledo Pipe Threading Machine Co.

PIPING SYSTEMS, FABRICATION WELDING
Galigher Co.
Grinnell Co., Inc.
The R. C. Mahon Co.
Midland Pipe & Supply Co.

PISTON RINGS
Koppers Co., Inc. Metal Products Div.—"AMERICAN HAMMERED INDUSTRIAL"

PIT PROPS, STEEL, YIELDING AND RIGID
Mining Progress, Inc.

PLANERS
Farrel-Birmingham Co., Inc.

PLANERS, COAL
Mining Progress, Inc.

PLATE ALLOY
Bethlehem Steel Co.
Crucible Steel Co. of America
Robert Holmes & Bros., Inc.
Jones & Laughlin Steel Corp.—"JALLOY"
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Revere Copper & Brass Inc.
U. S. Steel Corp.—"USS CARILLOY," "USST-1"
Youngstown Sheet & Tube Co.

PLATE, FLOOR
Robert Holmes & Bros., Inc.
Jones & Laughlin Steel Corp.—"JAL-THREAD"
Kanawha Mfg. Co.

PLATE, STEEL
Bethlehem Steel Co.
Colorado Fuel & Iron Corp.
Wickwire Spencer Steel Div.
Crucible Steel Co. of America
The Daniels Co., Contractors, Inc.
Guyan Machy. Co.
Robert Holmes & Bros., Inc.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Phoenix Iron & Steel Co.
W. J. Savage Co.
Stulz-Sickles Co.—"MANGANAL"
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

PLATE, STEEL, STAINLESS
Allegheny Ludlum Steel Corp.

PLATE, WROUGHT IRON
A. M. Byers Co.

PLATE & SHEET, ALUMINUM
Aluminum Company of America
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Reynolds Metals Co.

PLATE & SHEET, ZINC
Illinois Zinc Co.

PLIERS, ELECTRICIANS
Gensco Tools, Div. General Steel Warehouse Co., Inc.

PLUGS & RECEPTACLES, HIGH & LOW CURRENT & VOLTAGE
Albert & J. M. Anderson Mfg. Co.
Crouse-Hinds Co.
Delta-Star Electric Div., H. K. Porter Co. (Delaware)
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Ohio Brass Co.
United States Rubber Co.

POLE-LINE MATERIALS
Duquesne Mine Supply Co.
The Four Wheel Drive Auto Co.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Mosebach Electric & Supply Co.
Oliver Iron & Steel Corp.

POLES, TELEPHONE & TELEGRAPH
Republic Creosoting Co.

POLES, TREATED
Duquesne Mine Supply Co.
Graybar Elec. Co., Inc.
T. J. Moss Tie Co.

POLLUTION-CONTROL SYSTEMS
B-I-F Industries, Inc.
Bird Machine Co.
Bulkley, Dunton Processes, Inc.
Denver Equipment Co.—"DENVER"
Dorr-Oliver, Inc.
Heyl & Patterson, Inc.
Industrial Physics & Electronics Co.

POLLUTION-CONTROL SYSTEMS, AIR
American Air Filter Co.

POLYETHYLENE-FILM, SHEETING & TUBING
Gering Products, Inc.—"GERPAK" (T.M.)

PORTABLE BREAKERS
Athey Products Corp.

POST-HOLE DIGGERS
The Wood Shovel & Tool Co.

POSTERS, MINE SAFETY
Elliott Service Co., Inc.

POSTS, STEEL FENCE
American Steel & Wire—"AMERICAN"

POSTS, TREATED
T. J. Moss Tie Co.

POTHEADS
G & W Electric Specialty Co.

POWDER BAGS—SEE BAGS, POWDER

POWDER STORAGE, FIELD UNITS
Atlas Powder Co.
Dravo Corp.
E. I. du Pont de Nemours & Co., Inc., Explosives Div.
Hercules Powder Co.
King Powder Co., Inc.
National Powder Co.
Olin-Mathieson Chemical Corp., Explosives Div.

POWDERED METAL PARTS
Keystone Carbon Co.

POWER DIVIDERS
Vickers, Inc., Tulsa Winch Div.

POWER-FACTOR METERS, RECORDERS
The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Division
Westinghouse Electric Corp.

POWER UNITS, HYDRAULIC
American Blower, Div. of American-Standard
Denison Eng'g Div., American Brake Shoe Co.
Vickers, Inc.
Vickers, Inc., Tulsa Winch Div.

PREPARATION BUILDERS, CONTRACTORS
The Daniels Co., Contractors, Inc.—"DMS"
Nelson L. Davis Co.
Fairmont Machinery Co.
Heyl & Patterson, Inc.
Industrial Engrg. & Construction Co., Inc.
Link-Belt Co., Dept. CAMGL-57
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

PREPARATION PLANTS, PORTABLE
The Daniels Co., Contractors, INC.—"DMS"
Robert Holmes & Bros., Inc.
K. Prins & Associates

Thomas Engineering & Construction Co.
Western Machinery Co.—"WEMCO MOBIL-MILL"

PRESSES, HYDRAULIC
Denison Eng'g. Div. American Brake Shoe Co.
Farrel-Birmingham Co., Inc.
R. W. Nichols Co.

PROPS—See Roof Support

PULLERS, FUSE
Economy Fuse & Mfg. Co.
General Scientific Equipment Co.
Graybar Elec. Co., Inc.
Holub Industries, Inc.
Ideal Industries, Inc.
Martindale Electric Co.
Trico Fuse Mfg. Co.—"TRICO"

PULLERS, GEAR & WHEEL
Armstrong-Bray & Co.—"STEELGRIP"
Baerings, Inc.
Martindale Electric Co.
The Nolan Co.
Snap-on Tools Corp.
Templeton, Kenly & Co.—"SIMPLEX"

PULLERS, GEAR & WHEEL, HYDRAULIC
Armstrong-Bray & Co.—"HYDRAGRIP"
Beraings, Inc.
Templeton, Kenly & Co.—"RE-MO-TROL"

PULLEYS, CAST IRON
Continental Gin Co.
B. F. Goodrich Industrial Products Co.
Hewitt-Robins Incorporated
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McLanahan & Stone Corp.
Transall Inc.
Webster Mfg. Co.
T. B. Woods Sons Co.

PULLEYS, CONVEYOR — See Conveyors, Belt Idlers, Conveyor-Belt Idler Pulleys

PULLEYS, MOTORS
Reeves Pulley Co., Div. Reliance Electric & Engrg. Co.— "VARI-SPEED"

PULLEYS, PAPER
Browning Mfg. Co.
Webster Mfg., Inc.

PULLEYS, RUBBER-COVERED
United States Rubber Co.

PULLEYS, SEMI-STEEL
Continental Gin Co.
Hewitt-Robins Incorporated
McLanahan & Stone Corp.
Webster Mfg. Co.
T. B. Woods Sons Co.

PULLEYS, STEEL
The American Pulley Co.
Bonded Scale & Machine Co.—"BONDED"
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Dodge Mfg. Corp.—"TAPER-LOCK"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
E. F. Marsh Engrg. Co.—"MARCO"
Meckum Engr. Co.
W. J. Savage Co.
Sprout, Waldron & Co., Inc.—"BELTSAVER"
Transall Inc.

PULLEYS, WOOD
J. D. Christian Engineers

PULVERIZER PARTS, MANGANESE STEEL
American Brake Shoe Co., Amsco Div.—"AMSCO"

PULVERIZERS, COAL
Hardinge Co., Inc.

PULVERIZERS, FURNACE-FEED
Babcock & Wilcox Co.
Combustion Engineering, Inc.—"C-E-RAYMOND"
Foster Wheeler Corp.
Gruendler Crusher & Pulverizer Co.
Jeffrey Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Majac Inc.
Williams Patent Crusher & Pulv. Co.

PULVERIZERS, LABORATORY
Combustion Engineering, Inc.—"C-E-RAYMOND"
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Sturtevant Mill Co.
Universal Engineering Co.
Williams Patent Crusher & Pulv. Co.

PUMPING STATIONS
Acker Drill Co.

PUMP-PRIMING EQUIPMENT
Barrett, Haentjens & Co.
Flood City Brass & Electric Co.
Goyne Pump Co.
Nash Engineering Co.

PUMPS, AIR-DRIVEN
Emglo Products Div., M. Glosser & Sons Inc.—"EMGLO"
E. J. Longyear Co.

PUMPS, AIR-HYDRAULIC
Ledeen Mfg. Co.

PUMPS, ASH (WATER JET)
Canton Stoker Corp.—"WAGENER"

PUMPS, CENTRIFUGAL
Allen-Sherman-Hoff Pump Co.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Brake Shoe Co., Amsco Div.—"AMSCO"
American-Marsh Pumps, Inc.
American Well Works
Ampco Metal, Inc.
Aurora Div., The New York Air Brake Co.—"AURORA"
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.—"REX"
Construction Machy. Co.
Dean Brothers Pumps Inc.
The Deming Co.
Dorr-Oliver, Inc.
The Duriron Co., Inc.
Emglo Products Div., M. Glosser & Sons Inc.—"EMGLO"
Ensign Electric & Mfg. Co.
Flood City Brass & Electric Co.
Gardner-Denver Company
Gorman-Rupp Co.
Goulds Pumps, Inc.
Goyne Pump Co.
Guyan Machy. Co.—"GORMAN RUPP," "MYERS"
Homelite, Div. Textron Inc.—"HOMELITE"
Ingersoll-Rand Co.
LaBour Co., Inc.
Lancaster Pump & Mfg. Co.
Marlow Pumps, Div. of Bell & Gossett Co.
McNally-Pittsburg Mfg. Corp.
Morris Machine Works
Nagle Pumps, Inc.
National Mine Service Co.
Peerless Pump Div., Food Machinery & Chemical Corp.,
Pennsylvania Pump & Compressor Co.—"THRUSTFRE"
Rice Pump & Machine Co.
Roots-Connersville Blower, Div. Dresser Industries Inc.
Western Machinery Co.—"WEMCO"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, CENTRIFUGAL REBUILT
Leman Machine Co.

PUMPS, CENTRIFUGAL, SELF-PRIMING
American Well Works
Aurora Div., The New York Air Brake Co.—"AURORA"
Barnes Mfg. Co.
Buffalo Forge Co.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Carver Pump Co.
Chain Belt Co.—"REX"
Chicago Pneumatic Tool Co.
Construction Machy. Co.
The Deming Co.
The Duriron Co., Inc.
Ensign Electric & Mfg. Co.
Gorman-Rupp Co.
Goulds Pumps, Inc.
Guyan Machy. Co.—"GORMAN RUPP"
Homelite, Div. Textron Inc.—"HOMELITE"
Ingersoll-Rand Co.
Jaeger Machine Co.
LaBour Co., Inc.—"HYDRO-BALANCE"
Lancaster Pump & Mfg. Co.
Leman Machine Co.
Mall Tool Co., Div. of Remington Arms Co., Inc.—"MALL," "REMINGTON"
Marlow Pumps, Div. of Bell & Gossett Co.
Nagle Pumps, Inc.
Peerless Pump Div., Food Machinery & Chemical Corp.,
Rice Pump & Machine Co.
Worthington Corp.

PUMPS, CONCRETE GROUTING
E. J. Longyear Co.
Mobile Drilling Inc.

PUMPS, DIAPHRAGM
Barnes Mfg. Co.
B-I-F Industries, Inc.—"CHEM-O-FEEDER," "ADJUST-O-FEEDER," "PROPORTIONEER"
Carver Pump Co.
Chain Belt Co.—"REX"
Construction Machy. Co.
Denver Equipment Co.—"DENVER ADJUSTABLE STROKE"
Dorr-Oliver, Inc.
Eimco Corp.
Gardner-Denver Company
Gorman-Rupp Co.
Homelite, Div. Textron Inc.—"HOMELITE"
Guyan Machy. Co.—"GORMAN RUPP"
Marlow Pumps, Div. of Bell & Gossett Co.
Morse Bros. Machinery Co.
Ore Reclamation Co.
Rice Pump & Machine Co.
Western Machinery Co.—"WEMCO"
Worthington Corp.

PUMPS, DRUM
General Scientific Equipment Co.
Gray & Co., Inc.
Lincoln Engrg. Co.—"AIRLINE"

PUMPS, FIRE
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Porto Pump, Inc.

PUMPS, FROTH HANDLING
Denver Equipment Co.—"DENVER"

PUMPS, HIGH PRESSURE
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

PUMPS, HIGH VACUUM
Central Scientific Co.—"CENCO HYVAC"

PUMPS, HORIZONTAL—SHAFT
Nagle Pumps, Inc.—"TYPE-H"

PUMPS, JET

Aurora Pump Div., The New York Air Brake Co.—"AURORA"
Barnes Mfg. Co.
Construction Machy. Co.
The Deming Co.
Gorman-Rupp Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Lancaster Pump & Mfg. Co.
Porto Pump, Inc.

PUMPS, METERING

B-I-F Industries, Inc.
Roots-Connersville Blower, Div. Dresser Industries Inc.

PUMPS, OIL

Canton Stoker Corp.—"WAGENER"

PUMPS, PISTON & PLUNGER

Aldrich Pump Co.
American-Marsh Pumps, Inc.
Canton Stoker Corp.—"WAGENER"
Dean Brothers Pumps Inc.
The Deming Co.
Flood City Brass & Electric Co.
Gardner-Denver Company
Goulds Pumps, Inc.
Guyan Machy. Co.—"MYERS"
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Co.
Kinney Mfg. Div., New York Air Brake Co.—"KINNEY"
Lancaster Pump & Mfg. Co.
Ledeen Mfg. Co.
E. J. Longyear Co.
National Mine Service Co.
National Supply Company—"NATIONAL"
Worthington Corp.

PUMPS, PORTABLE SLUDGE AIR

Herold Mfg. Co.

PUMPS, RADIAL PISTON

American Engineering Co.—"HELE-SHAW," "HYRAMITE"

PUMPS, ROTARY

The Deming Co.

PUMPS, SAND, ABRASIVE HANDLING

Denver Equipment Co.—"DENVER S-R-L"

PUMPS, SOLIDS-HANDLING

Allen-Sherman-Hoff Pump Co.—"HYDROSEAL-CENTRISEAL"
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Brake Shoe Co., Amsco Div.—"AMSCO"
American-Marsh Pumps, Inc.
Aurora Div., The New York Air Brake Co.—"AURORA"
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Canton Stoker Corp. "WAGENER"
The Deming Co.
Dorr-Oliver, Inc.
Galigher Co.—"VACSEAL"
Gardner-Denver Company
Goulds Pumps, Inc.
Goyne Pump Co.
Gray & Co., Inc.
Guyan Machy. Co.—"WEMCO"
Linatex Corp. of America
Lincoln Engrg. Co.
Marlow Pumps, Div. of Bell & Gossett Co.
Morris Machine Works
Nagle Pumps, Inc.
Ore Reclamation Co.
Robbins & Meyers, Inc.—"MOYNO"
Western Machinery Co.—"WEMCO TORQUE FLOW"
A. R. Wilfley & Sons
Worthington Corp.

PUMPS, SUBMERSIBLE

Byron Jackson Pumps, Inc., A Sub of Borg-Warner Corp.
Guyan Machy. Co.
Lancaster Pump & Mfg. Co.

PUMPS, SUMP

Allen-Sherman-Hoff Pump Co.—"HYDROSEAL"
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American-Marsh Pumps, Inc.
Aurora Div., The New York Air Brake Co.—"AURORA"
Barnes Mfg. Co.
Barrett, Haentjens & Co.
Buffalo Forge Co.
Byron Jackson Pumps, Inc., A Sub of Borg-Warner Corp.
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
The Deming Co.
Emglo Products Div., M. Glosser & Sons, Inc.—"EMGLO"
Flood City Brass & Electric Co.
Galigher Co.—"GALIGHER"
Gardner-Denver Company
Gorman-Rupp Co.
Goulds Pumps, Inc.
Herold Mfg. Co.
Ingersoll-Rand Co.
Johnston Pump Co., Div of Youngstown Sheet and Tube Co.
Lancaster Pump & Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mall Tool Co., Div. of Remington Arms Co., Inc.—"MALL," "REMINGTON"
Marlow Pumps, Div. of Bell & Gossett Co.
Morris Machine Works
Nagle Pumps, Inc.
Peerless Pump Div., Food Machinery & Chemical Corp.
Penn Machine Co.
Robbins & Meyers, Inc.—"MOYNO"
Schramm, Inc.
Thor Power Tool Co.
Worthington Corp.

PUMPS, VACUUM

Canton Stoker Corp.—"WAGENER"
Joy Mfg. Co.
Nash Engineering Co.

PUMPS, VARIABLE DELIVERY

Nathan Mfg. Corp.

PUMPS, VERTICAL, CENTRIFUGAL

Barrett, Haentjens & Co.
Dean Brothers Pumps Inc.
Gorman Rupp Co.
Morris Machine Works
Nagle Pumps, Inc.

PUMPS, VERTICAL, CENTRIFUGAL AND TURBINE

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Well Works
Aurora Div., The New York Air Brake Co.—"AURORA"
Barnes Mfg. Co.
Buffalo Forge Co.
Byron Jackson Pumps, Inc. A Sub. of Borg-Warner Corp.
The Deming Co.
Ensign Electric & Mfg. Co.
Goulds Pumps, Inc.
Ingersoll-Rand Co.
Lancaster Pump & Mfg. Co.
Layne & Bowler, Inc.
Peerless Pump Div., Food Machinery & Chemical Corp.
Pennsylvania Drilling Co.
Worthington Corp.

PUMPS, VERTICAL, TURBINE,

Johnston Pump co., Div of The Youngstown Sheet & Tube Co.

PUSHBUTTONS

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Mosebach Electric & Supply Co.
Square D Co.
Westinghouse Electric Corp.

PYROMETERS

The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Minneapolis-Honeywell Regulator Co., Industrial Division—"ELECTRONIK"
West Instrument Corp.—"GARDSMAN-VERITELL"

RADIO SYSTEMS

General Electric Co., Communication Products Dept.
Graybar Elec. Co., Inc.
Mine Safety Appliances Co.—"MINE PHONE"
Motorola Communications & Electronics, Inc.

RAIL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
U. S. Steel Corp.
West Virginia Works, Connors Steel Div., H. K. Porter

RAIL BENDERS

Aldon Co.
Duquesne Mine Supply Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
Utility Mine Equipment Co.—"UMECO"
Watt Car & Wheel Co.

RAIL BOLTS

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"C F & I"
L. B. Foster Co.
Morse Bros. Machinery Co.
Oliver Iron & Steel Corp.
Pittsburgh Screw & Bolt Corp.
St. Louis Screw & Bolt Co.

RAIL-BOND TERMINALS

American Mine Door Co.

RAIL BONDS

American Steel & Wire—"TIGERWELD," "TIGERBRAZE"
Copperweld Steel Co. — "COPPERWELD"
Ensign Electric & Mfg. Co.
Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Brass Co.
Penn Machine Co.—"EVERLAST SUPER-WELD"
Schroeder Brothers Corp.

RAIL BRACES

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
The Nolan Co.
West Virginia Works, Conners Steel Div.

RAIL CLAMPS

Dravo Corp.
Duquesne Mine Supply Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Mosebach Electric & Supply Co.
Welman Engineering Co.
West Virginia Works, Conners Steel Div.

RAIL CROSSINGS, RUBBER

Goodyear Tire & Rubber Co.

RAIL DOLLIES

Templeton, Kenly & Co.—"SIMPLEX"

RAIL DRILLS

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Mall Tool Co.—"MALL," "REMINGTON"
Nordberg Mfg. Co.
Ohio Brass Co.

RAIL FROGS

Bethlehem Steel Co.

C. S. Card Iron Works
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Morse Bros. Machinery Co.
West Virginia Works, Conners Steel Div.

RAIL GRINDERS

Mall Tool Co.—"MALL," "REMINGTON"
Nordberg Mfg. Co.

RAIL PUNCHES

L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Mine Safety Appliances Co.—"VELOCITY-POWER"
National Mine Service Co.
Utility Mine Equipment Co.—"UMECO"

RAIL SIGNAL SYSTEMS, MANUAL & AUTOMATIC

American Mine Door Co.
Cheatham Elec. Switching Device Co.
Graybar Elec. Co., Inc.
Nachod & U. S. Signal Co.

RAIL SPIKES

Bethlehem Steel Co.
Colorado Fuel & Iron Corp. "C F & I"
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.

RAIL SPLICE BARS, PLATES

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"C F & I"
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Morse Bros. Machinery Co.
West Virginia Works, Conners Steel Div.

RAIL SPRING-SWITCH SNUBBERS

Cheatham Elec. Switching Device Co.

RAIL SWITCH-POSITION INDICATORS

American Mine Door Co.
Cheatham Elec. Switching Device Co.
L. B. Foster Co.
Joy Mfg. Co.
Miners' Hardware Supply Co.

RAIL SWITCHTHROWERS, AIR AUTOMATIC

American Mine Door Co.—"AERO-THROW"

RAIL SWITCHTHROWERS, ELECTRIC, AUTOMATIC

American Mine Door Co.—"ELECTRI-THROW"
Cheatham Elec. Switching Device Co.
L. B. Foster Co.
Joy Mfg. Co.

RAIL TIE HOLDERS

Leetonia Tool Co.

RAIL TIE PLATES

Bethlehem Steel Co.
L. B. Foster Co.
Morse Bros. Machinery Co.
U. S. Steel Corp.
West Virginia Works, Conners Steel Div.

RAIL TIES, PRESERVATIVE TREATED

T. J. Moss Tie Co.

RAIL TIES, STEEL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.
L. B. Foster Co.
National Mine Service Co.
West Virginia Works, Conners Steel Div.

RAIL TRACKWORK

American Brake Shoe Co., Railroad Products Div.

RAIL TURNOUTS, SWITCHES, STANDS

American Brake Shoe Co., Railroad Products Div.
Bethlehem Steel Co.
C. S. Card Iron Works
L. B. Foster Co.
West Virginia Works, Conners Steel Div.

RAIL WELDING

Metal & Thermit Corp.—"THERMIT"

RAIL WELDING MATERIALS

American Brake Shoe Co., Amsco Div.—"AMSCO"

RAIL & TRACK CONTACTORS

American Mine Door Co.
Nachod & U. S. Signal Co.

RAILS, GUARD

West Virginia Works, Conners Steel Div.

RAILS, TRANSITION

C. S. Card Iron Works
Miners' Hardware Supply Co.

RAMING MIXES

Mexico Refractories Co.—"FURN-A-RAM," "RAM-CAST," "HI-RAM"

REAMERS, SPIRAL EXPANSION

Martindale Electric Co.

RECTIFIERS, COPPER-OXIDE

Union Switch & Signal, Div. of Westinghouse Air Brake Co.

RECTIFIERS, GERMANIUM

I-T-E Circuit Breaker Co.

RECTIFIERS, MERCURY-ARC

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"EXCITRON"
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Hackbridge & Hewittic Electric Co., Ltd.
Herbert S. Littlewood
Westinghouse Electric Corp.

RECTIFIERS, MECHANICAL

I-T-E Circuit Breaker Co.

RECTIFIERS, SELENIUM

General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
Kersey Manufacturing Co., Inc.
Syntron Co.
Union Switch & Signal Div., Westinghouse Air Brake Co.
Westinghouse Electric Corp.

RECORDERS, OPERATING-HOUR

The Bristol Co.
General Electric Co., Apparatus Sales Div.

RECORDERS, TEMPERATURE

West Instrument Corp.—"MARKSMAN"

REDUCTION GEARS, INDUSTRIAL, ENGINE INSTALLATION

The Snow-Nabstedt Gear Corp.

REELS, LUBRICATING HOSE

Lincoln Engrg. Co.—"LUB-REELS"

REFRACTORIES

Babcock & Wilcox Co.
Bigelow-Liptak Corp.
Philip Carey Mfg. Co.
Corhart Refractories Co.
Joseph Dixon Crucible Co.
Johns-Manville —"FIRE-CRETE," "BLAZE-CRETE," "HELLITE," "FIREITE"
Norton Co.—"ALUNDUM," "CRYSTOLON," "MAGNORITE"

REFRACTORIES, ABRASION-RESISTANT

Corhart Refractories Co.—"CORHART ZAC ELECTRO-CAST REFRACTORY"

REFRACTORIES, CASTIBLE

Mexico Refractories Co.—"FURNAS-CRETE," "HI-STRENGTH F-303-S," "I-R-C 20," "MEXICAST," "MILL-CRETE," "PUROCAST 3000," "PUROTAB," "SAKONITE"

REFRACTORIES, CHROME

Mexico Refractories Co.—"CHROME CONCRETE," "HILO-CHROME," "MONO-CHROME," "SUPER CHROME CONCRETE"

REFRACTORIES, GRAPHITE

Mexico Refractories Co.—"HELSPOT," "HEL-SKOTE," "STULKOTE"

REFRACTORIES, PLASTIC

Mexico Refractories Co.—"MAX BOND," "MONO-FABRIK," "SUPER MONO-FABRIK, T-9"

REGULATORS, DRAFT

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division

REGULATORS, ELECTRIC CONTROL

Cutler-Hammer, Inc.

REGULATORS, PRESSURE

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
A. W. Cash Valve Mfg. Corp.
Fischer & Porter Co.
Hauck Mfg. Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
R. W. Nichols Co.—"M-B"
Rockwell Mfg. Co.

REGULATORS, TEMPERATURE

The Bristol Co.—"BRISTOL'S"
A. W. Cash Co.
Fischer & Porter Co.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.—"GARDSMAN"

REGULATORS, VOLTAGE

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Clark Controller Co.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
Square D Co.
Westinghouse Electric Corp.

RELAYS, ELECTRIC

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
American Mine Door Co.
Cheatham Elec. Switching Device Co.
Clark Controller Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Heinemann Elec. Co.—"SILICO-NETIC"
Joy Mfg. Co.
Nachod & U. S. Signal Co.
Square D Co.
Westinghouse Electric Corp.

RELAYS, MERCURY

Durakool, Inc.
Graybar Electric Co., Inc.
Joy Mfg. Co.
Mining Machine Parts Inc.

RELAYS, PNEUMATIC TIME DELAY, AGASTAT

Elastic Stop Nut Corp of America

REPAIR SERVICE, MINE EQUIPMENT

Flood City Brass & Electric Co.
W. J. Savage Co.
Simplicity Engineering Co.

REPRODUCTION EQUIPMENT

Charles Bruning Co., Inc.

REPRODUCTION MATERIALS

Keuffel & Esser Co.

REPRODUCTION MATERIALS, DRY-DEVELOPED

Keuffel & Esser Co.—"HELIOS"

REPRODUCTION MATERIALS, MOIST-DEVELOPED

Keuffel & Esser Co.—"ONYX"

RERAILERS

Aldon Co.
American Mine Door Co.
Duquesne Mine Supply Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Miner's Hardware Supply Co.
The Nolan Co.
Sanford Day Iron Works, Inc.

RESISTORS

Clark Controller Co.
Cutler-Hammer, Inc.
Ensign Electric & Mfg. Co.
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.—"GUYAN"
Jeffrey Mfg. Co.
Joy Mfg. Co.
Keystone Carbon Co.—"NTC"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ohio Carbon Co.—"OHIOHM"
Penn Machine Co.
The Post Glover Electric Co.—"P-G STEEL GRID"
Stackpole Carbon Co.
Westinghouse Electric Corp.

RESPIRATORS

E. D. Bullard Co.
Chicago Eye Shield Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Martindale Electric Co.
Mine Safety Appliances Co.—"COMFO," "DUSTFOE," "GASFOE"
Pulmosan Safety Equip. Co.
United States Rubber Co.
Willson Products Div., Ray-O-Vac Co.

RETAINERS, BEARING

Bearings, Inc.

RHEOSTATS

American Cyanamid Co., Explosives Dept.
Central Scientific Co.
Clark Controller Co.
Cutler-Hammer, Inc.
General Electric Co., Apparatus Sales Div.
Hercules Powder Co.
National Powder Co.
Westinghouse Electric Corp.

RIFFLE BUCKETS

Instrument Div., Gichner Inc.

RINGS, COLLECTOR, ARMATURE

Superior Carbon Products, Inc.
West Virginia Armature Co.

RIPPERS, BULLDOZERS, FRONT-MOUNTED

H & L Tooth Co.

RIPPERS, CABLE-CONTROLLED

Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

RIPPERS, HYDRAULIC

Tractomotive Corp.—"TRACTO-RIPPERS"

RIVER-LOADING PLANTS

Fairmont Machinery Co.
Heyl & Patterson, Inc.
Robert Holmes & Bro., Inc.
Link-Belt Co., Dept. CAMGL-57
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Welman Engineering Co., McDowell Enterprise

RIVETERS, PNEUMATIC

Cleco Div., Reed Roller Bit Co.

RIVETS

Bethlehem Steel Co.
Republic Steel Corp.—"REPUBLIC"

ROCK-DUST DISTRIBUTORS, DRY

American Mine Door Co.—"DUSTMASTER, MIGHTY MIDGET," "LITTLE CHIEF"
Imperial-Cantrell Mfg. Co.—"JET"
Mine Safety Appliances Co.—"BANTAM," "BANTAM 400," "FACE DUSTER TYPE S"

ROCK-DUST DISTRIBUTORS, WET

American Mine Door Co.—"LITTLE CHIEF"
Mine Safety Appliances Co.—"BANTAM 400 SLURRY TYPE"

RODS, LEVEL

Kern Instruments, Inc.

ROLLERS, CAST-IRON

Webster Mfg. Co.

ROLLERS, ROAD

Austin-Western Works, Construction Equipment Div., Baldwin-Lima-Hamilton
Blaw-Knox Co., Blaw-Knox Bldg.
Galion Iron Works & Mfg. Co.
Huber-Warco Co.—"HUBER-WARCO"

ROLLERS, SLOPE, CAST IRON, STEEL

C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
Sanford Day Iron Works, Inc.

ROLLERS, SLOPE, WOOD

C. S. Card Iron Works
J. V. Hammond Co.

ROLLERS, TRACTOR-TRACK REPLACEMENT

Sterling Steel Casting Co.

ROOF ARCHES, STEEL

Arrowhead Steel Buildings, Inc.
Mining Progress, Inc.

ROOF BARS, ALUMINUM

Reynolds Metals Co.

ROOF BARS, ALUMINUM HINGED

Herold Mfg. Co.

ROOF BARS, STEEL

Herold Mfg. Co.
Mining Progress, Inc.
West Virginia Works, Conners Steel Div.

ROOF-BOLT HOLE GAGES

Ohio Brass Co.

ROOF-BOLT PULLERS, HYDRAULIC

Continental Gin Co.

ROOF-BOLT TENSION INDICATORS

American Mine Supply Co.
Continental Gin Co.
Herold Mfg. Co.
Snap-on Tools Corp.

ROOF BOLTS, EXPANSION-SHELL

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"C F & I"
National Mine Service Co.
Oliver Iron & Steel Corp.
Pattin Mfg. Co.
Pittsburgh Screw & Bolt Corp.
Republic Steel Corp.—"REPUBLIC"
West Virginia Works, Conners Steel Div.
Youngstown Sheet & Tube Co.

ROOF BOLTS, MORTAR EMBEDMENT

Sika Chemical Corp.—"PERFO SYSTEM"

ROOF BOLTS, SQUARE HEAD

Sheffield Div., Armco Steel Corp.

ROOF BOLTS, WEDGE-TYPE

Bethlehem Steel Co.
Colorado Fuel & Iron Corp.—"C F & I"
National Mine Service Co.
Oliver Iron & Steel Corp.
Pattin Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
West Virginia Works, Conners Steel Div.
Youngstown Sheet & Tube Co.

ROOF DRAINS

J. Z. Zurn Mfg. Co.—"ZURN"

ROOF RESURFACERS

Stonhard Co.

ROOF SUPPORTS, ALUMINUM

Reynolds Metals Co.

ROOF SUPPORTS, YIELDING ARCH

Bethlehem Steel Co.
Herold Mfg. Co.
Mining Progress, Inc.

ROOF SUPPORTS, YIELDING MINE PROPS

Herold Mfg. Co.

ROOF VENTILATORS, POWER

American Blower, Div. of American-Standard

ROOFING, FLASHING, COPPER

Revere Copper & Brass Inc.

ROOFING, FLASHING NICKEL ALLOY

International Nickel Co., Inc.

ROOFING, FLASHING-ZINC

Illinois Zinc Co.

ROOFING, SIDING, ALUMINUM

Aluminum Company of America
The R. C. Mahon Co.
T. J. Moss Tie Co.
Revere Copper & Brass Inc.
Reynolds Metals Co.

ROOFING, SIDING, ASBESTOS

Philip Carey Mfg. Co.
Johns-Manville — "TRANSITE, FLEX-STONE"
Keasbey & Mattison Co.
The Ruberoid Co.

ROOFING, SIDING, ASPHALT

The Ruberoid Co.

ROOFING, SIDING, GALVANIZED

Arrowhead Steel Buildings, Inc.
Bethlehem Steel Co.
The R. C. Mahon Co.
T. J. Moss Tie Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
U. S. Steel Corp.

ROOFING, SIDING, ZINC

Illinois Zinc Co.

ROOTERS

LeTourneau-Westinghouse Co.

RUBBER, SILICONE

Dow Corning Corp.

SAFETY BELTS

E. D. Bullard Co.—"MORENCI"
General Scientific Equipment Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.

SAFETY DISPLAYS, SIGNS

American Optical Co.
Elliott Service Co., Inc.
General Scientific Equipment Co.
Mine Safety Appliances Co.—"M-S-A"

SAFETY EQUIPMENT

Mine Safety Appliances Co.

SAFETY FOOTGEAR, LEATHER

Hy-Test Safety Shoe Div., Inter-

national Shoe Co.
Mine Safety Appliances Co.

SAFETY FOOTGEAR, RUBBER
Goodall Rubber Co.
Mine Safety Appliances Co.

SAFETY HEADGEAR
American Optical Co.
E. D. Bullard Co.— "HARD-BOILED"
General Scientific Equipment Co.
Mine Safety Appliances Co.— "SKULL-GARD," "COMFO CAP"
National Mine Service Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"SAF-HED"
Willson Products Div., Ray-O-Vac Co.

SAFETY HOOKS
Crosby Laughlin Div. American Hoist & Derrick Co.— "CROSBY," "LAUGHLIN"
E. D. Bullard Co.—"BULLARD-BURNHAM"
Coffing Hoist Div., Duff-Norton Co.
General Scientific Equipment Co.

SAFETY SIGNS REFLECTORIZED
Mine Safety Appliances Co.— "SCOTCHLITE BRAND"

SALT
International Salt Co., Inc.— "STERLING"
Morton Salt Co.—"MORTON"

SALT, WITH RUST INHIBITOR
Diamond Crystal Salt Co.

SALT TABLETS
E. D. Bullard Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.— "PEP-UP"

SAMPLERS, COAL,
Denver Equipment Co.— "DENVER"
Fisher Scientific Co.
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-57
Mobile Drilling Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sturtevant Mill Co.

SAMPLERS, COAL, AUTOMATIC
Colorado Iron Works— "VEZIN"
Denver Equipment Co.— "DECO"
Galigher Co.—"GEARY JENNINGS"
Hardinge Co., Inc.
Heyl & Patterson, Inc.
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Sturtevant Mill Co.

SAND DRIERS
Barber-Greene Co.
J. D. Christian Engineers
Denver Equipment Co.
Eimco Corp.
Robert Holmes & Bros., Inc.
Indiana Foundry Co.—"SUTTON"
Iowa Mfg. Co.
Joy Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Pioneer Engineering, Div. of Poor & Co.

SAW BLADES
Gensco Tools Div., General Steel Warehouse Co., Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Martindale Electric Co.
Simonds Saw & Steel Co.— "SI-CLONE"

SAWS, BAND
Simonds Saw & Steel Co.

SAWS, BOW
Gensco Tools Div., General Steel Warehouse Co., Inc.

SAWS, CARBIDE-TIPPED
Simonds Saw and Steel Co.

SAWS, CHAIN, GASOLINE, AIR, ELECTRIC
Mall Tool Co., Div. of Remington Arms Co., Inc.— "MALL," "REMINGTON"

SAWS, CHAIN, PORTABLE, ELECTRIC, GASOLINE
Homelite, Div. Textron Inc.— "HOMELITE"

SAWS, CIRCULAR
Black & Decker Mfg. Co.
Mall Tool Co.—"MALL," "REMINGTON"
Martindale Electric Co.
Simonds Saw & Steel Co.— "RED CENTER"

SAWS, HACK
Graybar Elec. Co., Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Simonds Saw & Steel Co.
Snap-on Tools Corp.

SAWS, HAND
Henry Disston Div., H. K. Porter Co., Inc.
Gensco Tools Div., General Steel Warehouse Co., Inc.

SAWS, METAL CUTTING
Simonds Saw and Steel Co.

SAWS, MINE & UTILITY
Henry Disston Div., H. K. Porter Co., Inc.

SAWS, PORTABLE AIR
Herold Mfg. Co.

SAWS, PORTABLE ELECTRIC
Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Graybar Elec. Co., Inc.
Mall Tool Co.—"MALL," "REMINGTON"
Syntron Co.
Thor Power Tool Co.

SAWS, POWER
Graybar Elec. Co., Inc.
Lancaster Pump & Mfg. Co.
Thor Power Tool Co.

SAWS, POWER, AIR
Ingersoll-Rand Co.

SAWS, RECIPROCATING BLADE
Wright Power Saw & Tool Co., Sub. of Thomas Industries, Inc.

SCALE-WEIGHT RECORDERS
Buffalo Scale Co., Inc.
Cox & Stevens Electronic Scales Div., Revere Corp. of America—"COX & STEVENS"
Femco, Inc.
Howe Scale Co., Inc.
Industrial Physics & Electronics Co.
Koehring Co.
Streeter-Amet Co.
Taller & Cooper
Thurman Scale Co.
The Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCALE-WEIGHT RECORDERS, CONVEYOR
Merrick Scale Mfg. Co.— "WEIGHTOMETER"

SCALES, MINE-CAR, TRUCK
Buffalo Scale Co., Inc.
Cox & Stevens Electronic Scales Div., Revere Corp. of America —"COX & STEVENS"
Femco, Inc.
Howe Scale Co., Inc.
Morse Bros. Machinery Co.
Thurman Scale Co.
The Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCALES, PORTABLE TRUCK
Thurman Scale Co., Div. Thurman Mfg. Co.
Winslow Government Standard Scale Works, Inc.

SCALES, R. R.
Buffalo Scale Co., Inc.
Cox & Stevens Electronic Scales Div., Revere Corp. of America —"COX & STEVENS"
Morse Bros. Machinery Co.
Howe Scale Co., Inc.
The Webb Corp.
Winslow Government Standard Scale Works, Inc.

SCRAPER TIPS, TEETH
American Brake Shoe Co., Amsco Div.— "AMSCO"

SCRAPERS, DRAG
Jeffrey Mfg. Co.
Joy Mfg. Co.
Leubenstein Mfg. Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sauerman Bros., Inc.— "CRESCENT"

SCRAPERS, SELF-POWERED
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co. Industrial Equipment Div.
Caterpillar Tractor Co.
General Motors Corp., Euclid Division
International Harvester Co., Construction Equipment Div. —"PAYSCRAPER"
Joy Mfg. Co.
LeTourneau-Westinghouse Co. —"TOURNAPULL"
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

SCRAPERS, SHOT-HOLE
Leetonia Tool Co.

SCRAPERS, TRACTOR-POWERED
Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co. Industrial Equipment Div.
Caterpillar Tractor Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.
Oliver Corp.
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc.

SCRAPERS, UNDERGROUND
Eimco Corp.
Joy Mfg. Co.

SCREEN BARS
Colorado Fuel & Iron Corp.— "C F & I"
Robert Holmes & Bros., Inc.
Link-Belt Co., Dept. CAMGL-57
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Salem-Brosius, Inc.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.
Wedge Wire Corp.—"KLEEN-SLOT"

SCREEN CLOTH, WIRE
Bonded Scale & Machine Co.
Cambridge Wire Cloth
Cleveland Wire Cloth & Mfg. Co.
Colorado Fuel & Iron Corp.— "C F & I"
Diamond Iron Works, Div. Goodman Mfg. Co.
John Flocker & Co.
Hewitt-Robins Incorporated— "GYRALOY," "SUPER GYRALOY"
Hoyt Wire Cloth Co.
Iowa Mfg. Co.
Ludlow Saylor Wire Cloth Co. —"ARCHCRIMP," "STA-SMOOTH," "STA-CLEAN," "STA-TRU," "REKTANG," "LUDLOW," "SUPER-LOY," "PERFECT"
Newark Wire Cloth Co.

Pioneer Engineering, Div. of Poor & Co.
Simplicity Engineering Co.
W. S. Tyler Co.—"DOUBLE-CRIMP," "TON-CAP," "TY-ROD," "CORDUROY"

SCREEN-CLOTH HEATERS

The Deister Concentrator Co.—"FLEXELEX"
F. R. Hannon & Sons—"HANCO"
Link-Belt Co., Dept. CAMGL-57
Productive Equipment Corp.
Screen Equipment Co., Inc.—"HANNON"
Simplicity Engineering Co.
W. S. Tyler Co.— "TY-ELECTRIC"

SCREEN PLATE, PERFORATED

Bonded Scale & Machine Co.
Chicago Perforating Co.
John Flocker & Co.
The Harrington & King Perforating Co., Inc.
Hendrick Mfg. Co.
Robert Holmes & Bros., Inc.
Iowa Mfg. Co.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Pioneer Engineering, Div. of Poor & Co.
Remaly Mfg. Co. Inc.
Salem-Brosius, Inc.
W. J. Savage Co.
Simplicity Engineering Co.
Stephens-Adamson Mfg. Co.

SCREEN SECTIONS, REPLACEMENT

Cleveland Wire Cloth & Mfg. Co.
Link-Belt Co., Dept. CAMGL-57

SCREENS, CENTRIFUGAL

Bird Machine Co.—"BIRD-HUMBOLDT"
Cambridge Wire Cloth
Centrifugal & Mech. Industries, Inc.—"C-M-I"
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Heyl & Patterson, Inc.—"REINEVELD"
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Newark Wire Cloth Co.
Nordberg Mfg. Co.—"SYMONS"
W. S. Tyler Co.

SCREENS, DEWATERING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bird Machine Co.
Bonded Scale & Machine Co.—"BONDED"
Cambridge Wire Cloth
Denver Equipment Co.—"DENVER"
Fairmont Machinery Co.
Hendrick Mfg. Co.
Jeffrey Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.— "MECKUM SKB"
Newark Wire Cloth Co.
The Nolan Co.
Nordberg Mfg. Co. — "SYMONS"
Productive Equipment Corp.—"GYROSET," "SELECTRO," "KELLEY"
Screen Equipment Co. Inc.—"SECO"
Simplicity Engineering Co.
Smith Engineering Works—"TELSMITH"
W. S. Tyler Co.
Universal Road Machinery Co.
Wedge Wire Corp.—"KLEEN-SLOT"

SCREENS, REVOLVING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Denver Equipment Co.—"DENVER"
Diamond Iron Works, Div. Goodman Mfg. Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Lippmann Engrg. Works Inc.
McLanahan & Stone Corp.
Meckum Engr. Co.
Nordberg Mfg. Co.—"SYMONS," "V-SCREEN"
Pioneer Engineering, Div. of Poor & Co.
W. J. Savage Co.
Smith Engineering Works—"TELSMITH"
Straub Mfg. Co., Inc.
W. S. Tyler Co.
Universal Engineering Co.
Universal Road Machinery Co.
Webster Mfg., Inc.

SCREENS, ROD

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bixby-Zimmer Engineering Co.
Link-Belt Co., Dept. CAMGL-57
Nordberg Mfg. Co. — "SYMONS"
W. S. Tyler Co.—"TY-LOC"

SCREENS, SHAKER

Bonded Scale & Machine Co.—"BONDED"
Cambridge Wire Cloth
Central Scientific Co.
Colorado Fuel & Iron Corp.
Fairmont Machinery Co.
Fisher Scientific Co.
Gruendler Crusher & Pulverizer Co.
Helmick Foundry-Machine Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Industrial Engrg. & Construction Co., Inc.
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Laubenstein Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McLanahan & Stone Corp.
Newark Wire Cloth Co.
Pioneer Engineering, Div. of Poor & Co.
K. Prins & Associates
Remaly Mfg. Co. Inc.
McNally-Pittsburg Mfg. Corp.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.
Stephens-Adamson Mfg. Co.
W. S. Tyler Co.

SCREENS, TESTING

Commercial Testing & Engineering Co.

SCREENS, VIBRATING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bonded Scale & Machine Co.—"BONDED"
Cambridge Wire Cloth
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
The Deister Concentrator Co.—"LEAHY HEAVY DUTY NO BLIND"
Deister Machine Co.
Denver Equipment Co.—"DENVER-DILLON"
Diamonds Iron Works, Div. Goodman Mfg. Co.
Dravo Corp.
Fairmont Machinery Co.
Gruendler Crusher & Pulverizer Co.
Hendrick Mfg. Co.
Hewitt-Robins Incorporated—"HI-G," "VIBREX," "ELIPTEX," "GYREX," "HI-SPEED," "HYDREX"
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Kennedy-Van Saun Mfg. & Engrg. Corp.
Lecco Machinery & Engineering Co.—"LECCO-VIB"
Link-Belt Co., Dept. CAMGL-57—"BA," "CA"
Lippmann Engrg. Works Inc.
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Morse Bros. Machinery Co.
Newark Wire Cloth Co.
Nordberg Mfg. Co.—"SYMONS"
Ore Reclamation Co.
Pioneer Engineering, Div. of Poor & Co.—"SUPER SERVICE MESABI"
Productive Equipment Corp.—"GYROSET," "SELECTRO," "KELLEY"
Remaly Mfg. Co. Inc.
Screen Equipment Co. Inc.—"SECO"
Simplicity Engineering Co.—"SIMPLI-FLO"
Smith Engineering Works—"TELSMITH"
Stedman Foundry & Machine Co., Inc.
Stephens-Adamson Mfg. Co.
Straub Mfg. Co., Inc.
Sturtevant Mill Co.
Syntron Co.
W. S. Tyler Co.—"HUM-MER," "TY-ROCK," "TYLER-NIAGARA," "TY-ROCKET"
Universal Engineering Co.
Universal Vibrating Screen Co.—"UNIVERSAL," "UNILEC," "UNIFLEX"
Williams Patent Crusher & Pulv. Co.

SCREENS, VIBRATING, TESTING

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Denver Equipment Co.—"DENVER-DILLON"
Gilson Screen Co.
Hendrick Mfg. Co.
Robert Holmes & Bros., Inc
Link-Belt Co., Dept. CAMGL-57
Newark Wire Cloth Co.
Productive Equipment Corp.
Syntron Co.
W. S. Tyler Co.—"RO-TAP," "TY-LAB"
Universal Vibrating Screen Co.—"UNIVERSAL," "UNILEC," "UNIFLEX," "UNIVIBE"

SCREENS, WEDGE-WIRE

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Bixby-Zimmer Engineering Co.
Hendrick Mfg. Co.—"WEDGE-SLOT"
Wedge Wire Corp.—"KLEEN-SLOT"

SCREW WASHERS

Link-Belt Co., Dept. CAMGL-57

SCREWS, CAP & SET

St. Louis Screw & Bolt Co.

SCREWS, SET

Leetonia Tool Co.

SCRUBBERS, AIR

Johnson-March Corp.—"TYPE A HYDRO-PRECIPITATOR"

SEALS, BEARING, GREASE & OIL

Bearings, Inc.
Garlock Packing Co.—"KLOZURES"
Greene, Tweed & Co.—"PALMETTO," "G-T-RINGS"
Johns-Manville—"CLIPPER"
United States Rubber Co.
West Virginia Armature Co.

SEALS, SHAFT, MECHANICAL

Anchor Packing Co.
Bearings, Inc.
Byron Jackson Pumps, Inc., A Sub. of Borg-Warner Corp.
Garlock Packing Co.—"MECHANIPAK"
Greene, Tweed & Co.—"PALMETTO"
Koppers Co., Inc., Metal Products Div.
Syntron Co.
United States Rubber Co.

SECTIONAL DISTRIBUTION CENTERS, ELECTRICAL

Distribution Assemblies Dept., General Electric Co.

SEISMOGRAPHS, BLASTING

Vibration Measurement Engineers, Inc.

SELF-RESCUERS

Mine Safety Appliances Co.

SEPARATORS, AIR

Hardinge Co., Inc.
I-T-E Cirucuit Breaker Co.
Majac, Inc.
New Jersey Meter Co.—"DRIAIR"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Sturtevant Mill Co.
Universal Road Machinery Co.
Williams Patent Crusher & Pulv. Co.

SEPARATORS, HEAVY-MEDIA

Western Machinery Co.—"WEMCO CONE," "WEMCO DRUM"

SERVICE TRUCKS, SELF PROPELLED

Schroeder Brothers Corp.

SHAFT HANGERS

J. D. Christian Engineers
Continental Gin Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
W. J. Savage Co.
Webster Mfg., Inc.
Wilmot Engineering Co.

SHAFT RIGS, PNEUMATIC

Schroeder Brothers Corp.

SHAFT & TUNNEL SUPPORTS, STEEL, PLATES, RIBS, SETS & LAGGING

The Commercial Shearing & Stamping Co.

SHAFTING, STEEL

Bethlehem Steel Co.
Bonded Scale & Machine Co.
Robert Holmes & Bros., Inc.
Jeffrey Mfg. Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Transall Inc.
Bertrand P. Tracy Co.

SHAFTS, FLEXIBLE

Mall Tool Co.—"MALL," "REMINGTON"

SHAPERS

South Bend Lathe Works

SHAPES, STRUCTURAL, ALUMINUM

Aluminum Company of America
Robert Holmes & Bros., Inc.
Reynolds Metals Co.

SHEARS, PORTABLE ELECTRIC

Black & Decker Mfg. Co.

SHEAVES, HOISTING

American Brake Shoe Co., Amsco Div.—"AMSCO"
C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Kensington Steel, Div. of Poor & Co.
McLanahan & Stone Corp.
Nordberg Mfg. Co.
Pittsburg Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
The Tool Steel Gear & Pinion Co.
Vulcan Iron Works—"ALL-CASTEEL"
Wilmot Engineering Co.

SHEAVES, TRACK

C. S. Card Iron Works
Robert Holmes & Bros., Inc.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"

SHEAVES, V-BELT

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"TEXROPE"
The American Pulley Co.—"WEDG-TITE"
Bonded Scale & Machine Co.
Boston Woven Hose & Rubber Co.
Browning Mfg. Co.
J. D. Christian Engineers
Continental Gin Co.
Dayton Rubber Co.
Dodge Mfg. Corp.—"TAPER LOCK"
Flood City Brass & Electric Co.
Gates Rubber Co.
Guyan Machy. Co.
Hewitt-Robins Incorporated—"JONES"
Industrial Rubber Products Co. (Pa.)
Iowa Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
National Mine Service Co.
New York Belting & Packing Co.
Ore Reclamation Co.
Pittsburg Gear Co.
Transall Inc.
T. B. Woods Sons Co.
Worthington Corp.

SHEAVES, WIRE-ROPE

American Brake Shoe Co., Amsco Div.—"AMSCO"
C. S. Card Iron Works
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Robert Holmes & Bros., Inc.
Joy Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Nordberg Mfg. Co.
Pittsburgh Gear Co.
Sanford Day Iron Works, Inc.
Sauerman Bros., Inc.—"DUROLITE"
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Vulcan Iron Works—"ALL-CASTEEL"
T. B. Woods Sons Co.

SHELVING, RACKS, ETC.

Frick-Gallagher Mfg. Co.
National Mine Service Co.

SHIM STOCK, SHIMS

Crucible Steel Co. of America
B. F. Goodrich Industrial Products Co.

SHIPLOADERS, MOBILE & STATIONARY

Welman Engineering Co., McDowell Enterprise

SHOCK ABSORBERS, MACHINE & MOTOR MOUNTS

Continental Rubber Works
Goodyear Tire & Rubber Co.
New York Belting & Packing Co.—"GILMER SHOCK PADS"
United States Rubber Co.

SHOTFIRERS

American Mine Door Co.
Femco, Inc.
King Powder Co., Inc.
Mine Safety Appliances Co.
National Mine Service Co.
Olin-Mathieson Chemical Corp., Explosives Div.

SHOVELS, HAND

O. Ames Co.—"RED EDGE, MONOGAH, KNOXALL"
Gibraltar Equipment & Mfg. Co.
National Mine Service Co.
The Salem Tool Co.
The Wood Shovel & Tool Co.

SHOVELS, STANDARD POWER-TYPE, COAL LOADING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Gar Wood Industries, Inc.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Orton Crane & Shovel Co.
Quick-Way Truck Shovel Co.
Schield Bantam Co.
Thew Shovel Co.—"LORAIN"
Unit Crane & Shovel Corp.

SHOVELS, STRIPPING

American Hoist & Derrick Co.—"AMERICAN"
Baldwin-Lima-Hamilton Corp., Construction Equipment Div.—"LIMA"
Bay City Shovels, Inc.
Bucyrus-Erie Co.
Eimco Corp.
Harnischfeger Corp.
Koehring Co.
Link-Belt Speeder Corp.
Manitowoc Engineering Corp.
Marion Power Shovel Co.
Northwest Engineering Co.
Quick-Way Truck Shovel Co.
Thew Shovel Co.—"LORAIN"

SHOVELS, TRACTOR

Allis-Chalmers Mfg. Co., Construction Machinery Div.

SHOWER-ROOM EQUIPMENT

Onox, Inc.—"ONOX FOOT-MATS, ONOX SKIN-TOUGHENER"
J. Z. Zurn Mfg. Co.—"ZURN"

SIEVES, TESTING

Central Scientific Co.
Fisher Scientific Co.
Newark Wire Cloth Co.
W. S. Tyler Co.—"TYLER STANDARD SCREEN-SCALE"

SIGNALS, BELL & HORN

Graybar Elec. Co., Inc.
Taller & Cooper

SIGNALS, HAULAGE

Nachod & U. S. Signal Co.

SIGNALS, LIGHT CASES

Nachod & U. S. Signal Co.

SILOS, ASH, COAL & SAND STORAGE

Butler Mfg. Co.
Fairfield Engineering Co.
Marietta Concrete Corp.
Neff & Fry Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

SKIDS, MINE-CAR

Duquesne Mine Supply Co.
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Miners' Hardware Supply Co.
Sanford Day Iron Works, Inc.

SKIP WHEELS

American Brake Shoe Co., Amsco Div.—"AMSCO"

SKIPS, AUTOMATIC LOADING EQUIPMENT

Robert Holmes & Bros., Inc.

SKIPS, MINE-HOISTING

Connellsville Mfg. & Mine Supply Co.
Fairfield Engineering Co.
Hewitt-Robins Incorporated
Robert Holmes & Bros., Inc.
Mayo Tunnel & Mine Equipment Co.
Nordberg Mfg. Co.
The Stearns-Roger Mfg. Co.
Vulcan Iron Works
Webster Mfg., Inc.

SLIDE RULES

Keuffel & Esser Co.
Roberts & Schaefer Co., Sub.

Thompson-Starrett Co., Inc.

SLINGS, BELT

C. R. Daniels Co.
B. F. Goodrich Co., Industrial Products Div.
Goodyear Tire & Rubber Co.
Hewitt-Robins Incorporated
New York Belting & Packing Co.—"ROUGH RIDER"
Raybestos Manhattan, Inc., Manhattan Rubber Div.

SLINGS, CHAIN

American Chain & Cable Co., Inc., American Chain Div.
John Flocker & Co.
Manning, Maxwell & Moore, Inc.—"TIPIT"
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.

SLINGS, WOVEN WIRE

Cambridge Wire Cloth

SLINGS, WIRE-ROPE

American Chain & Cable—"ACCO REGISTERED," "DUALOC"
Bergen Wire Rope Co.
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND" "B & B BROLOC"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WICKWIRE," "MAXI-FLEX," "MULTIFLEX," "UNIFLEX," "DURAGRIP"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.
Macwhyte Co.
National Mine Service Co.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Union Wire Rope Corp.—"TUFFY"
Upson-Walton Co.
Wire Rope Corp. of America, Inc.

SLOTTERS

Farrel-Birmingham Co., Inc.

SLUDGE RECOVERY SYSTEMS

Link-Belt Co., Dept. CAMGL-57

SMOKE CONTROL SYSTEMS

Canton Stoker Corp.

SLUSHERS, SCRAPER

Joy Mfg. Co.

SNOW PLOWS

Walter Motor Truck Co.

SOIL SOLIDIFICATION

Manu-Mine Research & Development Co.

SOILS, TESTING

Mobile Drilling Inc.

SOLENOIDS

Cheatham Elec. Switching Device Co.
Cutler-Hammer, Inc.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
R. W. Nichols Co.—"MAC"
Trombetta Solenoid Corp.

SOLVENTS, CLEANING

American Minechem Co.
Cities Service Oil Co.
Columbia-Southern Chemical Corp.
E. I. du Pont de Nemours & Co., Inc.
Esso Standard Oil Co.
Fisher Scientific Co.
Martindale Electric Co.
Shell Oil Co.
Sun Oil Co.
Wyandotte Chemicals Corp.

SOUND PROTECTORS

American Optical Co.—"STRAIGHT-AWAY"

SPAD DRIVERS

American Mine Supply Co.

SPAD HANGERS

American Mine Supply Co.

SPADS

American Mine Supply Co.
Black Diamond Spad Co.—"BLACK DIAMOND"
Howells Mining Drill Co.—"HOWELLS"

SPECTACLES, SAFETY

American Optical Co.—"FULVUE ULTRASCOPIC"
E. D. Bullard Co.
Fisher Scientific Co.
General Scientific Equipment Co.
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.—"STYL-IZE"
Willson Products Div., Ray-O-Vac Co.

SPEED INCREASERS

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI-PITCH"
J. D. Christian Engineers
Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Hewitt-Robins Incorporated—"JONES"
Link-Belt Co., Dept. CAMGL-57
Philadelphia Gear Works
U. S. Electrical Motors, Inc.—"SYNCRO GEAR"
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS

Allis-Chalmers Mfg. Co., Industrial Equipment Div.—"VARI-PITCH"
The American Pulley Co.—"SHAFT-KING," "SCREW-KING"
Bonded Scale & Machine Co.
J. D. Christian Engineers —"RITE LO SPEED"
Cleveland Worm & Gear Co.
Cone-Drive Gears Div., Michigan Tool Co.
Continental Gin Co.
Dodge Mfg. Corp.—"TORQUE-ARM"
Falk Corp.—"FALK"
Farrel-Birmingham Co., Inc.
Foote Brothers Gear & Machinery Corp.—"HYGRADE," "LINE-O-POWER," "MAXI-POWER," "LINE-O-MOUNT"
Hewitt-Robins Incorporated—"JONES"
Link-Belt Co. Dept. CAMGL-57—"LINK-BELT," "IN-LINE HELICAL," "PARALLEL SHAFT," "GEAR-MOTOR," "P. I. V."
Master Electric Co.
Morse Chain Co., A Borg-Warner Industry—"EBERHARDT DENVER"
R. W. Nichols Co.—"PNEU-TROL"
Ore Reclamation Co.
Philadelphia Gear Works—"MOTO REDUCER"
Square D Co.
Stephens-Adamson Mfg. Co.—"SACO"
Transall Inc.
U. S. Electrical Motors, Inc.—"SYNCROGEAR"
Westinghouse Electric Corp.
Worthington Corp.

SPEED REDUCERS, WORM

Link-Belt Co., Dept. CAMGL-57

SPIKES, TRACK—See Rail Spikes

SPIRALS, COAL

Western Machinery Co.—"WEMCO"

SPLICING COMPOUNDS, MATERIALS—See Conveyor Belting Splicing Materials

SPRAY COMPOUNDS

Johnson-March Corp.—"COMPOUND MR"

SPRAY OILS

Ashland Oil & Refining Co.—"ASHLAND PERMA-TREAT"
Cities Service Oil Co.
Esso Standard Oil Co.
Keenan Oil Co.—"KEENOIL 7"
Shell Oil Co.
Standard Oil Co.
Sun Oil Co.—"COAL KOTE"
The Texas Co.
Valvoline Oil Co., Div. Ashland Oil & Refining Co.

SPRAYERS, HIGH-PRESSURE

Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.

SPRAYING EQUIPMENT—See also Dustproofing Equipment

SPRAYING EQUIPMENT, OIL

Gray & Co., Inc.
Keenan Oil Co.
Sanford Day Iron Works, Inc.
W. J. Savage Co.

SPRAYING EQUIPMENT, WATER & COMPOUNDS

Gray & Co., Inc.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp.
Johnson-March Corp.
Plastex Co.

SPROCKETS

American Brake Shoe Co., Amsco Div.—"AMSCO"
Bonded Scale & Machine Co.
Browning Mfg. Co.
Chain Belt Co.—"REX"
J. D. Christian Engineers
Continental Gin Co.
Diamond Chain Co., Inc.
Dodge Mfg. Corp.—"TAPER LOCK"
Helmick Foundry-Machine Co.
Iowa Mfg. Co.
Jeffrey Mfg. Co.
Kensington Steel, Div. of Poor & Co.
Link-Belt Co., Dept. CAMGL-57
McLanahan & Stone Corp.
McNally-Pittsburg Mfg. Corp.
Meckum Engr. Co.
Mining Machine Parts, Inc.—"ANGALOR"
Morse Chain Co., A Borg-Warner Industry
Mosebach Electric & Supply Co.
National Mine Service Co.
Ore Reclamation Co.
Penn Machine Co.
W. J. Savage Co.
Taylor-Wharton Co. Div. Harsco Corp.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Transall Inc.
Whitney Chain Co.
Wilmot Engineering Co.

SPROCKETS, CAST-IRON

Link-Belt Co., Dept. CAMGL-57
Webster Mfg., Inc.

SPROCKETS, COAL CUTTERS

Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Frank Prox Company, Inc.
The Tool Steel Gear & Pinion Co.
Bertrand P. Tracy Co.
Whitney Chain Co.

SPROCKETS, CUT-TOOTH

Link-Belt Co., Dept. CAMGL-57

SPROCKETS, ROLLER CHAIN

Flood City Brass & Electric Co.

SPROCKETS, TAPER-BORE

Link-Belt Co., Dept. CAMGL-57

STACKERS, RECLAIMERS, COAL

Barber-Greene Co.

Dravo Corp.
Link-Belt Co., Dept. CAMGL-57
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

STAIR TREADS
Blaw-Knox Co.
Dravo Corp.
General Scientific Equipment Co.
Jones & Laughlin Steel Corp.
New York Belting & Packing Co.
Joseph T. Ryerson & Son, Inc.

STARTERS—SEE MOTOR CONTROLLERS, STARTERS

STARTERS, ENGINE, HYDRAULIC
Hydramotive, Inc.

STEAM TRACED PIPE, ALUMINUM
Aluminum Co. of America—"UNITRACE"

STEEL, ABRASION-RESISTING
American Brake Shoe Co., Amsco Div—"AMSCO"
American Steel & Wire
Bethlehem Steel Co.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Stulz-Sickles Co.—"MANGANAL"
Taylor-Wharton Co., Div., Harsco Corp.
U. S. Steel Corp.—"USS A-R"
Youngstown Sheet & Tube Co.

STEEL, ALLOY
American Brake Shoe Co., Amsco Div.—"AMSCO"
American Steel & Wire
Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Electric Steel Foundry Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
Simonds Saw & Steel Co.
Stulz-Sickles Co.
The Timken Roller Bearing Co.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

STEEL, ALLOY, FREE MACHINING
Crucible Steel Co. of America

STEEL, CARBON
American Steel & Wire
Bethlehem Steel Co.
Crucible Steel Co. of America
Colorado Fuel & Iron Corp. —"C F & I"
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Phoenix Iron & Steel Co., Structural & Tube Divs.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
U. S. Steel Corp.
Youngstown Sheet & Tube Co.

STEEL, CORROSION-RESISTANT
Allegheny Ludlum Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America
Electro-Alloys Div. American Brake Shoe Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Youngstown Sheet & Tube Co.

STEEL, DIE
Simonds Saw and Steel Co.

STEEL, GALVANIZED
Inland Steel Co.—"TM-TI-CO"

STEEL, HEAT RESISTANT ALLOY
Electro-Alloys Div., American Brake Shoe Co.

STEEL, HIGH-STRENGTH
American Steel & Wire
Bethlehem Steel Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Inland Steel Co.—"TM-HI-STEEL," "HI-MAN"
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Sheffield Div., Armco Steel Corp.
Stulz-Sickles Co.
U. S. Steel Corp.—"USS COR-TEN," "USS MAN-TEN," "USS TRI-TEN"
Youngstown Sheet & Tube Co.

STEEL, STAINLESS
Allegheny Ludlum Steel Corp.
American Steel & Wire
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crucible Steel Co. of America
Henry Disston Div., H. K. Porter Co., Inc.
Electric Steel Foundry Co.
Kanawha Mfg. Co.
Republic Steel Corp.—"REPUBLIC ENDUR"
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Simonds Saw & Steel Co.
U. S. Steel Corp.

STEEL, STRUCTURAL
Arrowhead Steel Buildings, Inc.
Colorado Fuel & Iron Corp. —"C F & I"
Bethlehem Steel Co.
Dravo Corp.
Robert Holmes & Bros., Inc.
Inland Steel Co.
Jones & Laughlin Steel Corp.
Kanawha Mfg. Co.
The R. C. Mahon Co.
Phoenix Iron & Steel Co., Structural & Tube Divs.
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Sheffield Div., Armco Steel Corp.
U. S. Steel Corp.

STEEL, TOOL
Allegheny Ludlum Steel Corp.
Bethlehem Steel Co.
Crucible Steel Co. of America—"REX"
Gardner-Denver Company
Jones & Laughlin Steel Corp.
Republic Steel Corp.—"REPUBLIC"
Joseph T. Ryerson & Son, Inc.
Simonds Saw & Steel Co.
The Timken Roller Bearing Co.

STOKERS
Axeman-Anderson Co.—"ANTHRATUBE"

STOKERS, CHAIN-GRATE
Babcock & Wilcox Co.—"JET-IGNITION"
Laclede Stoker Co. — "LACLEDE 'F' TYPE, "LACLEDE 'L' TYPE"
Combustion Engineering, Inc.—"C-E"

STOKERS, SPREADER
American Engineering Co.—"AE PERFECT SPREAD"
Combustion Engineering, Inc.—"C-E"
Dayton Automatic Stoker Co.
Hoffman Combustion Engrg. Co.—"FIRITE"
Laclede Stoker Co.—"LACLEDE-UNIVERSAL"

STOKERS, TRAVELING GRATE
Combustion Engineering, Inc.—"C-E"

STOKERS, UNDERFEED
American Engineering Co.—"TAYLOR"
Auburn Foundry, Inc., Heating Div.—"AUBURN"
Canton Stoker Corp.—"CANTON"
Carpenter Heating & Air Conditioning Co.—"CARPENTER"
Combustion Engineering, Inc.—"C-E"
Dayton Automatic Stoker Co.—"MARINE"

STOKERS, VIBRATING GRATE
American Engineering Co.—"VIBRA-GRATE"

STOPERS, ROOF-BOLTING
Acme Machinery Co.
Gardner-Denver Company
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.—"VAC-NU-MATIC"
Penn Machine Co.
Schroeder Brothers Corp.
Thor Power Tool Co.

STOPPINGS, STEEL DEMOUNTABLE
Tri-County Building Service—"AIRTITE"

STORAGE SYSTEMS, COAL
Link-Belt Co., Dept. CAMGL-57

STOVES, HEATING
Indiana Foundry Co.

STOVES, SAND DRYING
Indiana Foundry Co.

STOWING MACHINES, BELT SLINGERS
Herold Mfg. Co.

STRAINERS, PUMP
Barrett, Haentjens & Co.
Goyne Pump Co.
S. P. Kinney Engineers, Inc.
J. Z. Zurn Mfg. Co.—"ZURN"

SUBSTATIONS, OUTDOOR
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Delta-Star Electric Div., H. K. Porter Co., (Delaware)
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Westinghouse Electric Corp.

SUBSTATIONS, UNIT
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Square D Co.
Westinghouse Electric Corp.

SUGGESTION SYSTEMS, POSTERS, BOXES, FORMS
Elliott Service Co., Inc.

SULPHUR ANALYZERS, RAPID
Laboratory Equipment Corp.—"LECO"

SUPERVISORY-CONTROL SYSTEMS
B-I-F Industries, Inc.—"SYNCHRO-SCAN"
The Bristol Co.—"METAMETER TELEMETERING"
Femco, Inc.
Industrial Physics & Electronics Co.
General Electric Co., Apparatus Sales Div.

SURVEYING EQUIPMENT
C. L. Berger & Sons, Inc.—"BERGER"
Charles Bruning Co., Inc.
Brunson Instrument Co.
Copperweld Steel Co., Wire & Cable Div.
Geo-Optic Co., Inc.
Gurley, W. & L. E.
Keuffel & Esser Co.
Suverkrop Instruments
Wild Heerbrugg Instruments, Inc.

SWEATBANDS
Pulmosan Safety Equip. Co.

SWITCHBOARDS
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Cutler-Hammer, Inc.
Distribution Assemblies Dept., General Electric Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Ironton Engine Co.—"IRONTON"
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ready Power Co.—"READY-POWER"
Square D Co.
Taller & Cooper
Westinghouse Electric Corp.

SWITCH BOXES
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
National Electric Products Co.
Westinghouse Electric Corp.

SWITCH HOUSES
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Mosebach Electric & Supply Co.
Westinghouse Electric Corp.

SWITCHERS, RR CAR
LeTourneau-Westinghouse Co.—"SWITCH MOBILE," "SWITCH-TRACTOR"

SWITCHES, AIR FLOW CONTROLLED MERCURY TUBE
Guyan Machy. Co.

SWITCHES, BELT CONTROL
Schroeder Brothers Corp.

SWITCHES, CONVEYOR-CONTROL
Femco, Inc.
General Electric Co., Apparatus Sales Div.
Joy Mfg. Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRIC HAND
Cheatham Electric Switching Device Co.
Nachod & U. S. Signal Co.

SWITCHES, ELECTRICAL
Arrow Hart & Hegeman Electric Co.—"QUIETTE"
Cheatham Elec. Switching Device Co.
Circuit Protective Devices, Dept., General Electric Co.
Clark Controller Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.
Dooley Brothers
The Elreco Corp.—"POWER"
G & W Electric Specialty Co.
General Electric Co., Apparatus Sales Div.
General Electric Co., Construction Materials Dept.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Joy Mfg. Co.
Ohio Brass Co.
McGill Mfg. Co., Inc.—"LEVOLIER"
Mosebach Electric & Supply Co.
Nachod & U. S. Signal Co.
National Mine Service Co.
Square D Co.
Stackpole Carbon Co.
Westinghouse Electric Corp.

SWITCHES, ELECTRICAL HIGH-VOLTAGE
Delta-Star Electric Div., H. K. Porter Co., (Delaware)

SWITCHES, ELECTRICAL, SAFETY
Arrow Hart & Hegeman Electric Co.
Circuit Protective Devices Dept., General Electric Co.
Crouse-Hinds Co.
Cutler-Hammer, Inc.—"C-H"
Dooley Brothers
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Square D Co.
Westinghouse Electric Corp.

SWITCHES, LOCOMOTIVE-TRANSFER
Circuit Protective Devices Dept., General Electric Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Jeffrey Mfg. Co.
The Post Glover Electric Co.—"P-G"

SWITCHES, MERCURY
Crouse-Hinds Co.
Durakool, Inc.
Femco, Inc.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
The Post Glover Electric Co.—"P-G"

SWITCHES, ROPE-PULL MOMENTARY
Cheatham Electric Switching Device Co.
Nachod & U. S. Signal Co.

SWITCHES, THERMOCOUPLE
West Instrument Corp.

SWITCHGEAR
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Electric Machinery Mfg. Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
I-T-E Circuit Breaker Co.
Herbert S. Littlewood
Square D Co.
Westinghouse Electric Corp.

TABLE DECKS, WASHING
Linatex Corp. of America

TABLES, AIR-CLEANING
Fairmont Machinery Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.—"SUPER-AIRFLOW"

TABLES, COAL-WASHING
The Daniels Co., Contractors, Inc.
The Deister Concentrator Co.—"SUPER DUTY DIAGONAL DECK," "CONCENCO '77' DIAGONAL DECK"
Deister Machine Co.
Link-Belt Co., Dept. CAMGL-57

TABLES, DRAFTING
Charles Bruning Co., Inc.

TACHOMETERS
The Bristol Co.—"BRISTOL'S"
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Ideal Industries, Inc.
Martindale Electric Co.
Minneapolis-Honeywell Regulator Co., Industrial Division
Stewart-Warner Corp., Alemite Div.
Taller & Cooper
Westinghouse Electric Corp.

TAKEOFFS, POWER
Gar Wood Industries, Inc.
Schroeder Brothers Corp.
Twin Disc Clutch Co.
Vickers, Inc., Tulsa Winch Div. —"TULSA"

TAKEOFFS, POWER, SPLIT SHAFT TYPE
Hendrickson Mfg. Co.

TAKEUPS, CONVEYOR
Barber-Greene Co.
Bearings, Inc.
Chain Belt Co., Shafer Bearing Div.
J. D. Christian Engineers
Hewitt-Robins, Incorporated
Irwin Foundry & Mine Car Co.
Jeffrey Mfg. Co.
Joy Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp.
Pioneer Engineering, Div. of Poor & Co.
Roberts & Schaefer Co., Sub Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.

TAKE-UP UNITS, BALL-BEARING
SKF Industries, Inc.

TAKE-UP UNITS, SPHERICAL ROLLER BEARING
SKF Industries, Inc.

TAMPERS, BACKFILL
Cleco Div., Reed Roller Bit Co.

TAMPERS, PNEUMATIC
Schroeder Brothers Corp.

TAMPERS, SHOTHOLE
Leetonia Tool Co.
The Salem Tool Co.

TAMPING BAGS—See Bags, Tamping

TAMPING PLUGS
National Mine Service Co.
National Powder Co.

TAMPING STICKS, WOOD
Duquesne Mine Supply Co.
Gibraltar Equipment & Mfg. Co.
J. V. Hammond Co.
National Mine Service Co.
National Powder Co.
The Salem Tool Co.

TANKS, CLARIFYING, SLUDGE RECOVERY
Fairmont Machinery Co.
Denver Equipment Co.—"DENVER"
Eagle Iron Works
Link-Belt Co., Dept. CAMGL-57
Peterson Filters & Engineering Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

TANKS, PLASTIC-LINED
Galigher Co.

TANKS, RUBBER-LINED
Denver Equipment Co.—"DENVER"
Galigher Co.
Gates Rubber Co.
B. F. Goodrich Co., Industrial Products Div.
Industrial Rubber Products Co. (Pa.)
Linatex Corp. of America
Quaker Rubber Div., H. K. Porter Co.
Raybestos Manhattan, Inc. Manhattan Rubber Div.
United States Rubber Co.

TANKS, STEEL
Bethlehem Steel Co.
Blaw-Knox Co.
Butler Mfg. Co.
The Daniels Co., Contractors, Inc.
Denver Equipment Co.—"DENVER"
Robert Holmes & Bros., Inc.
Kanawha Mfg. Co.
L. O. Koven & Bro., Inc.
The R. C. Mahon Co.
Phoenix Iron & Steel Co., Structural & Tube Divs.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
W. J. Savage Co.

TANKS, WOOD
Denver Equipment Co.—"DENVER"

TAPE, ADHESIVE
Johns-Manville — "DUTCH BRAND"

TAPE, BONDING
B. F. Goodrich Industrial Products Co.

TAPE, COATED, POLYESTER MAT
Irvington Div., Minnesota Min-

ing & Mfg. Co.

TAPE, ELECTRICAL, PLASTIC

Boston Woven Hose & Rubber Co.
Continental Rubber Works
Dayton Rubber Co.—"HOL-FAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Graybar Elec. Co., Inc.
Johns-Manville — "JOMANCO"
National Mine Service Co.
Okonite Co.
Plymouth Rubber Co., Inc.—"PLYMOUTH"
United States Rubber Co.

TAPE, FRICTION

Boston Woven Hose & Rubber Co.
Continental Rubber Works
Dayton Rubber Co.—"HOLE-FAST"
Goodall Rubber Co.
B. F. Goodrich Industrial Products Co.
Graybar Elec. Co., Inc.
Guyan Machy. Co.
Industrial Rubber Products Co. (Pa.)
Jenkins Bros.
Johns-Manville — "4-STAR"
Mosebach Electric & Supply Co.
National Electric Coil Co.
National Mine Service Co.
New York Belting & Packing Co.—"GREAT SEAL"
Okonite Co.
Plymouth Rubber Co., Inc.—"SLIPKNOT"
Quaker Rubber Div., H. K. Porter Co.
The Ruberoid Co.
United States Rubber Co.
West Virginia Armature Co.

TAPE, GLASS-CLOTH

Graybar Elec. Co., Inc.
Johns-Manville
National Electric Coil Co.—"MICA-GLAS"

TAPE, GLASS-CLOTH, COATED

Irvington Div., Minnesota Mining & Mfg. Co.—"FIBRE-MAT"

TAPE, INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section—"V-C" "IRRATHENE," "MICAMAT"

TAPE, OZONE-RESISTANT

Plymouth Rubber Co., Inc.—"PLYMOZONE"

TAPE, RUBBER

Boston Woven Hose & Rubber Co.
Continental Rubber Works
Dayton Rubber Co.—"HOL-FAST"
Goodall Rubber Co.
Graybar Elec. Co., Inc.
Jenkins Bros.
Johns-Manville
Mosebach Electric & Supply Co.
National Electric Coil Co.
National Mine Service Co.
New York Belting & Packing Co.—"GREAT SEAL"
Okonite Co.
Plymouth Rubber Co., Inc.—"P. R."
Quaker Rubber Div., H. K. Porter Co.
United States Rubber Co.
West Virginia Armature Co.

TAPE, VARNISHED-CAMBRIC

Graybar Elec. Co., Inc.
Irvington Div., Minnesota Mining & Mfg. Co.
National Electric Coil Co.

TAPE, VULCANIZING

American Mine Door Co.

TAPES, MEASURING

Charles Bruning Co., Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Graybar Elec. Co., Inc.
Keuffel & Esser Co.
Lufkin Rule Co.

TAPS, CABLE & TROLLEY, FUSED

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mining Machine Parts, Inc.—"MMP JABCO"
Mosebach Electric & Supply Co.
Ohio Brass Co.
Standard Devices Co.

TARPAULINS

Bemis Bro. Bag Co.—"DRI-TITE"
Fulton Bag & Cotton Mills

TELEMETERING SYSTEMS

Taller & Cooper

TELEPHONES, BATTERY

Crouse-Hinds Co.
Graybar Elec. Co., Inc.

TELEPHONES, SOUND-POWERED

Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Mining Progress, Inc.

TELEPHONES, TROLLEY

Femco, Inc.
Industrial Physics & Electronics Co.
Mine Safety Appliances Co.—"MINEPHONE"

TELEVISION SYSTEMS

Diamond Power Specialty Co.—"UTILISCOPE," "UTILI-VUE"
Femco, Inc.—"DAGE T. V."
Graybar Elec. Co., Inc.

TEMPERATURE INDICATORS, CONTROLLERS

B-I-F Industries, Inc.—"CHRONOFLO"
The Bristol Co.—"BRISTOL'S"
Goodman Mfg. Co.
Fischer & Porter Co.
Fisher Scientific Co.
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Hays Corp.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.—"GARDSMAN-VERI-TELL"
Westinghouse Electric Corp.

TERMINATORS

Delta-Star Electric Div., H. K. Porter Co., (Delaware)

TEST STANDS, HYDRAULIC

Fischer & Porter Co.
Schroeder Brothers Corp.—"UNIVERSAL"
Vickers, Inc.

TESTERS, CARBON MONOXIDE

Mine Safety Appliances Co.

TESTERS, INSULATION

Electrical Distributors Co.
Ideal Industries, Inc.
Martindale Electric Co.

TESTERS, INSULATORS

I-T-E Circuit Breaker Co.

TESTERS, PORTABLE HYDRAULIC

Schroeder Brothers Corp.—"PT-50-B"

TESTERS, RAIL-BOND

Mosebach Electric & Supply Co.
Ohio Brass Co.

TESTERS, VOLTAGE

Fisher Scientific Co.
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Holub Industries, Inc.
I-T-E Circuit Breaker Co.
Ideal Industries, Inc.
Martindale Electric Co.
Square D Co.
Westinghouse Electric Corp.

THEODOLITES, OPTICAL, MINING

Kern Instruments, Inc.

THERMOCOUPLES

The Bristol Co.—"BRISTOL'S"
Foxboro Co.
General Electric Co., Apparatus Sales Div.
Minneapolis-Honeywell Regulator Co., Industrial Division
West Instrument Corp.

THREADING MACHINES, PIPE & BOLT

Beaver Pipe Tools, Inc.
The Oster Mfg. Co.

THREADING TOOLS, PIPE

Beaver Pipe Tools, Inc.

THROTTLE CONTROLS

Link-Belt Speeder Corp.—"SPEED-O-TROL"

THICKENERS

American Well Works
Denver Equipment Co.—"DENVER-STANDARD," "DENVER HEAVY-DUTY AUTOMATIC"
Dorr-Oliver, Inc.
Eimco Corp.
B. F. Goodrich Chemical Co.—"GOOD-RITE CARBOPOL 934"
Hardinge Co., Inc.
Link-Belt Co., Dept. CAMGL-57
Morse Bros. Machinery Co.
Peterson Filters & Engineering Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Western Machinery Co.—"WEMCO"

THINNERS, ELECTRIC INSULATING

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

TIE REMOVERS, REPLACERS

Gibraltar Equipment & Mfg. Co.

TIES, CROSS, SWITCH

Republic Creosoting Co.

TIMBER—See also Roof Bars, Arches, Supports

TIMBER, ALUMINUM

Reynolds Metals Co.

TIMBER, PRESSURE-CREOSOTED

Koppers Co., Inc. Wood Preserving Div.

TIMBER, PRESSURE-TREATED

Koppers Co., Inc., Wood Preserving Div.—"WOLMANIZED"

TIMBER, TREATED, UNTREATED

T. J. Moss Tie Co.

TIMBER, YIELDING STEEL PROPS

Mining Progress, Inc.
T. J. Moss Tie Co.

TIMBER FRAMERS

Denver Equipment Co.—"DENVER"
Stearns-Roger Mfg. Co.

TIMBER PULLERS

Penn Machine Co.
Templeton, Kenly & Co.—"SIMPLEX"

TIMBER-TREATING MATERIALS

Darworth, Inc., Cuprinol Div.—"CUPRINOL"
The Dow Chemical Co.
Monsanto Chemical Co., Organic Chemicals Div.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS, OSMOPLASTICS, M-T-M"

TIMBERING MACHINES

Rugger Equipment, Inc.—

"RUGER TIMBERLIFT"

TIMERS, MERCURY

Durakool, Inc.
Joy Mfg. Co.

TIRE RECAPPING, REPAIRING, EARTHMOVER

Carolina Tire Co.

TIRES, EARTHMOVER

Carolina Tire Co.

TIRES, MINE

Mitchell Industrial Tire, Inc.—"MITCO TROUBLE FREE"

TIRES, RUBBER

Dayton Rubber Co.—"THOROBRED"
Firestone Tire & Rubber Co.
Gates Rubber Co.
B. F. Goodrich Tire Co.
Goodyear Tire & Rubber Co.
Seiberling Rubber Co.
United States Rubber Co.
W. Va. Belt & Cable Repairs, Inc.—"MITCO INDUSTRIAL"

TIRES, STEEL

National Mine Service Co.
Bertrand P. Tracy Co.

TIRES, STEEL TURNING

Leman Machine Co.

TOOLS, DRILLING

Stardrill-Keystone Co.

TOOLS, ELECTRICAL-CONNECTOR

Burndy Engrg. Co., Inc.—"HY-TOOLS, HYPRESSES"
Erico Products, Inc.—"CAD-WELD"
Graybar Elec. Co., Inc.
Joy Mfg. Co.

TOOLS, HAND

Guyan Machy. Co.—"PROTO," "CHALLENGER"
Proto Tool Co., Div. of Pendleton Tool Industries, Inc.

TOOLS, MECHANICS

Ampco Metal, Inc.—"AMPCO SAFETY"
Bearings, Inc.
Henry Disston Div., H. K. Porter Co., Inc.
Gensco Tools Div., General Steel Warehouse Co., Inc.
Graybar Elec. Co., Inc.
Snap-on Tools Corp.

TOOLS, PORTABLE, AIR

Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Ensign Electric & Mfg. Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Joy Mfg. Co.
Le Roi Div., Westinghouse Air Brake Co.
Mall Tool Co.—"MALL," "REMINGTON"
Marathon Coal Bit Co., Inc.—"BUCKEYE"
Penn Machine Co.
Schramm, Inc.
Schroeder Brothers Corp.
Snap-on Tools Corp.
Thor Power Tool Co.
Worthington Corp.

TOOLS, PORTABLE, ELECTRICAL

Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Ensign Electric & Mfg. Co.
Graybar Elec. Co., Inc.
Ingersoll-Rand Co.
Mall Tool Co.—"MALL," "REMINGTON"
Martindale Electric Co.
Penn Machine Co.
Joseph T. Ryerson & Son, Inc.
Snap-on Tools Corp.
Syntron Co.
Thor Power Tool Co.

TOOLS, POWDER-POWERED

Mine Safety Appliances Co.—"VELOCITY-POWER"
Remington Arms Co., Inc.—"REMINGTON INDUSTRIAL KILN GUN," "REMINGTON STUD DRIVER"

TOOLS, TRACK

Aldon Co.
L. B. Foster Co.
Gibraltar Equipment & Mfg. Co.
Leetonia Tool Co.
Mall Tool Co.—"MALL," REMINGTON"

TORQUE CONVERTERS

Clark Equip. Co., Automotive Div.—"CLARK-TORCON"
National Supply Company—"NATIONAL"
Twin Disc Clutch Co.

TOWBOATS

Dravo Corp.
Marietta Mfg. Co.

TOWERS, BARGE-UNLOADING

Dravo Corp.
Heyl & Patterson, Inc.
Link-Belt Co., Dept. CAMGL-57
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Stephens-Adamson Mfg. Co.
Welman Engineering Co., McDowell Enterprise

TOWERS, HYDRAULIC

Mobile Aerial Towers, Inc.—"HI-RANGER"

TRACK CLEANERS

American Mine Door Co.—"CANTON"

TRACK SHOES, POWER SHOVEL

American Steel Foundries—"WEARPACT"

TRACTOR-COMPRESSOR UNITS

Gardner-Denver Company
Le Roi Div., Westinghouse Air Brake Co.—"TRACTAIR"

TRACTORS DOZERS

Clark Equipment Co., Construction Machinery Div.—"MICHIGAN"

TRACTOR GROUSER BARS

American Brake Shoe Co., Amsco Div.—"AMSCO"

TRACTOR GROUSERS

American Steel Foundries—"WEARPACT"

TRACTOR POWER CONTROL UNITS

LeTourneau-Westinghouse Co.

TRACTOR RAIL & GROUZERS, MANGANESE

Kensington Steel, Div. of Poor & Co.

TRACTOR SPROCKET RIMS, MANGANESE

Kensington Steel, Div. of Poor & Co.

TRACTORS, CRAWLER

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
J. I. Case Co.—"CASE-TERRATRAC"
Caterpillar Tractor Co.
Diesel Energy Corp.
Eimco Corp.
General Motors Corp., Euclid Division
International Harvester Co., Construction Equipment Div.
Minneapolis-Moline Co.
Oliver Corp.—"OLIVER"

TRACTORS, CRAWLER, UNDERGROUND

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Eimco Corp.
International Harvester Co., Construction Equipment Div.
Joy Mfg. Co.

TRACTORS, RUBBER-TIRED MINE

Allis Chalmers Mfg. Co., Industrial Equipment Div.
Caterpillar Tractor Co.
Kersey Manufacturing Co., Inc.

TRACTORS, TRUCK HAULAGE

Dart Truck Co.
The Four Wheel Drive Auto Co.
Henrickson Mfg. Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Mack Trucks, Inc.
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.

TRACTORS, WHEELED

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
J. I. Case Co.—"CASE"
Caterpillar Tractor Co.
Diesel Energy Corp.
The Frank G. Hough Co.
International Harvester Co., Construction Equipment Div.
LeTourneau-Westinghouse Co.—"TOURNATRACTOR TWIN C"
Minneapolis-Moline Co.
Oliver Corp.—"OLIVER"
Walter Motor Truck Co.

TRAILER AXLES

Clark Equip. Co., Automotive Div.—"CLARK"
Winter-Weiss Co.

TRAILER BODIES

Baughman Mfg. Co., Inc.
Perfection Steel Body Co.
Winter-Weiss Co.

TRAILER, FULL

Fruehauf Trailer Co.

TRAILERS, BOTTOM-DUMP

Athey Products Corp.
General Motors Corp, Euclid Division
Perfection Steel Body Co.
Sanford Day Iron Works, Inc.
Truck Engineering Co.

TRAILERS, SIDE-DUMP

Athey Products Corp.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, REAR-DUMP

Athey Products Corp.
Galion Allsteel Body Co.
Hercules Steel Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, SEMI

Fruehauf Trailer Co.

TRAILERS, SEMI, BOTTOM-DUMP

Dart Truck Co.
Hockensmith Corp.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, SEMI, SIDE-DUMP

Baughman Mfg. Co., Inc.—"HYDRAULIC"
Hockensmith Corp.
LeTourneau-Westinghouse Co.—"TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRAILERS, SEMI, REAR-DUMP

Hockensmith Corp.
Le Tourneau-Westinghouse Co. "TOURNAPULL"
Marion Metal Products Co.
Perfection Steel Body Co.
Truck Engineering Co.

TRANSFER CASES

Clark Equip. Co., Automotive Div.
The Four Wheel Drive Auto Co.

Timken Detroit Axle Div., Rockwell Spring & Axle Co.

TRANSFORMERS, CONTROL, INSTRUMENT

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
The Bristol Co.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
Hevi-Duty Electric Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSFORMERS, POWER

Allis-Chalmers Mfg. Co., Industrial Equipment Div.
General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Graybar Elec. Co., Inc.
F. R. Hannon & Sons—"HANCO"
Hevi-Duty Electric Co.
I-T-E Circuit Breaker Co.
Kuhlman Elec. Co.
Herbert S. Littlewood
Moloney Electric Co.—"HYPERCORE"
Morse Bros. Machinery Co.
Mosebach Electric & Supply Co.
National Mine Service Co.
Wagner Electric Corp.
Westinghouse Electric Corp.

TRANSITS, ENGINEER'S

Charles Bruning Co., Inc.
Suverkrop Instruments

TRANSMISSIONS, AUTOMOTIVE

Allison Div., General Motors Corp.—"TORQMATIC"
Clark Equip. Co., Automotive Div.—"CLARK"
The Four Wheel Drive Auto Co.
Fuller Mfg. Co.
Timken-Detroit Axle Div. Rockwell Spring & Axle Co.

TRANSMISSIONS, REVERSING

The Snow-Nabstedt Gear Corp.

TRANSMISSIONS, VARIABLE SPEED

Link-Belt Co., Dept. CAMGL-57
Reeves Pulley Co., Div. Reliance Electric & Engineering Co. "VARI-SPEED"

TRANSPORTERS, CONTINUOUS MINERS

Leman Machine Co.

TREADPLATE, ALUMINUM

Aluminum Co. of America

TREADPLATE, ALUMINUM, ABRASIVE

Aluminum Co. of America

TRIP LAMPS

Concordia Electric Co.—"CEAG"
General Electric Co., Lamp Div.—"GENERAL ELECTRIC"
Mine Safety Appliances Co.—"EDISON R-4"
National Mine Service Co.

TROLLEY CLAMPS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY, CONVEYOR

Link-Belt Co., Dept. CAMGL-57

TROLLEY FROGS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY FROGS, ELECTRIC

Cheatham Elec. Switching Device Co.
Ohio Brass Co.

TROLLEY GUARDS

Ensign Electric & Mfg. Co.
John Flocker & Co.
B. F. Goodrich Industrial Products Co.—"KOROSEAL"
Guyan Machy. Co.—"VISI-GARD"
Mosebach Electric & Supply Co.
National Mine Service Co.
Mine Safety Appliances Co.
Ohio Brass Co.
Raybestos Manhattan, Inc. Manhattan Rubber Div.
United States Rubber Co.

TROLLEY HANGERS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Mosebach Electric & Supply Co.
Ohio Brass Co.

TROLLEY HARPS, SHOES, SLIDERS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Ohio Carbon Co.

TROLLEY POLES, WOOD

Duquesne Mine Supply Co.
Flood City Brass & Electric Co.
J. V. Hammond Co.

TROLLEY-SHOE CONTRACTORS

American Mine Door Co.
Cheatham Elec. Switching Device Co.
Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Nachod & U. S. Signal Co.
Ohio Brass Co.
Ohio Carbon Co.

TROLLEY SIGNALS SYSTEMS

American Mine Door Co.
Nachod & U. S. Signal Co.

TROLLEY SPLICES

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
West Virginia Armature Co.

TROLLEY SYSTEMS

The Elreco Corp.—"ELRECO"
Ohio Brass Co.

TROLLEY TAPS — See Taps, Trolley & Cable

TROLLEY WHEELS

Duquesne Mine Supply Co.
The Elreco Corp.—"ELRECO"
Flood City Brass & Electric Co.
Jeffrey Mfg. Co.
Mosebach Electric & Supply Co.
Ohio Brass Co.
Ohio Carbon Co.
Pittsburgh Gear Co.

TROLLEY WHEELS, CONVEYOR

Link-Belt Co., Dept. CAMGL-57

TROLLEYS, I-BEAM

Coffing Hoist Div., Duff-Norton Co.

TROWELS

Henry Disston Div., H. K. Porter Co., Inc.

TRUCK AXLES

Eaton Mfg. Co., Axle Div.
Ford Motor Co.
The Four Wheel Drive Auto Co.

TRUCK AXLES, DRIVING

Ford Motor Co.
The Four Wheel Drive Auto Co.

TRUCK BODIES

Baughman Mfg. Co., Inc.
Ford Motor Co.
Galion Allsteel Body Co.
Gar Wood Industries, Inc.
Hercules Steel Products Co.
Hockensmith Corp.—"PENN"
Perfection Steel Body Co.
Truck Engineering Co.

TRUCK BODY FLOORS, ALUMINUM

Revere Copper & Brass, Inc.

TRUCK BOGIES

Clark Equip. Co., Automotive Div.—"CLARK"
Ford Motor Co.
The Four Wheel Drive Auto Co.
Hendrickson Mfg. Co.

TRUCK DRIVES, TANDEM-AXLE

Clark Equip. Co., Automotive Div.—"CLARK"
Eaton Mfg. Co., Axle Div.
Ford Motor Co.
Hendrickson Mfg. Co.
Marmon - Herrington Co., Inc.

TRUCK SAFETY STEPS

E. D. Bullard Co.

TRUCKS, AUTOMOTIVE

Chevrolet Motor Div.
Dodge Div., Chrysler Corp.—"DODGE POWER GIANTS"
Ford Motor Co.
The Four Wheel Drive Auto Co.
Hendrickson Mfg. Co.
International Harvester Co., Construction Equipment Div.
International Harvester Co., Motor Truck Div.—"INTERNATIONAL"
Koehring Co.
Mack Trucks, Inc.
Marmon - Herrington Co., Inc.
Oshkosh Motor Truck, Inc.
Reo Motors, Inc.
Walter Motor Truck Co.

TRUCKS, FORK LIFT

Hyster Co.—"HYSTER," "SPACE SAVER," "MONO-MAST"

TRUCK, MINE-CAR

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
National Malleable & Steel Castings Co.—"NATIONAL NC-1"
Sanford Day Iron Works, Inc.

TRUCKS, MINE-LOCOMOTIVE

Penn Machine Co.

TRUCKS, OFF-HIGHWAY

Dart Truck Co.
General Motors Corp., Euclid Div.
International Harvester Co., Construction Equipment Div.—"PAYHAULER"

TUBING AND TUBE FITTINGS

Anchor Coupling Co., Inc.

TUBING, ELECTRICAL MECHANICAL

Youngstown Sheet & Tube Co.

TUBING, FLEXIBLE-METAL

Cobra Metal Hose, Div., DK Mfg. Co.

TUBING, PLASTIC AND COATED

Irvington Div., Minnesota Mining & Mfg. Co.

TUBING, STEEL

National Tube Div., U. S. Steel Corp.—"USS SHELBY"

TUBING, SEAMLESS STEEL

The Timken Roller Bearing Co.

TUBING, STAINLESS-STEEL

Crucible Steel Co. of America
National Tube Div., United States Steel Corp.—"USS SHELBY"

TUGBOATS

Wiley Mfg. Co.

TURNBUCKLES

Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Bethlehem Steel Co.
Duquesne Mine Supply Co.
Ohio Brass Co.
Joseph T. Ryerson & Son, Inc.
St. Louis Screw & Bolt Co.
Upson-Walton Co.

TURNBUCKLES, INSULATED
The Elreco Corp.

TURNERS, WHEEL-FLANGE & TREAD
Transall Inc.

UNLOADERS
Clyde Iron Works, Inc.

VACUUM CLEANING, SWEEPING EQUIPMENT
Black & Decker Mfg. Co.
Ideal Industries, Inc.
Martindale Electric Co.

VALVE ACTUATORS, CYLINDER
Ledeen Mfg. Co.

VALVE REFACERS & GRINDERS
Black & Decker Mfg. Co.

VALVES, ANGLE
Detroit Controls Corp., D. T. Williams Valves
Jenkins Bros.

VALVES, ANGLE & Y
The Duriron Co., Inc.
Electric Steel Foundry Co.
The Fairbanks Co.
Farris Flexible Valve Corp.—"XV DIAPHRAGM SEAL"
Homestead Valve Mfg. Co.
Midland Pipe & Supply Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Walworth Co.
D. T. Williams Valve Co., Div. The Schaible Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, AUTOMATIC FULL FLOW QUICK OPENING AND SHUTOFF
Coppus Engineering Corp.—"SENTRY"

VALVES, AIR
The Lunkenheimer Co.—"LUNKENHEIMER"
Schroeder Brothers Corp.

VALVES, BUTTERFLY
S. P. Kinney Engineers, Inc.

VALVES, CHECK
Allen-Sherman-Hoff Pump Co.—"FLEX-CHECK," "RUBBER LINED"
Barrett, Haentjens & Co.
Crane Co.
Detroit Controls Corp. D. T. Williams Valves
Electric Steel Foundry Co.
The Fairbanks Co.
Farris Flexible Valve Corp.—"FLEX VALVE"
Goyne Pump Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
The Lunkenheimer Co.—"FERRENEWO," "N-M-D," "RENEWO"
Midland Pipe & Supply Co.
R. W. Nichols Co.—"PNEU-TROL"
Ohio Brass Co.
Osmose Wood Preserving Co.—"TECHNOCHECK"
R-P & C Valve Div., American Chain & Cable Co., Inc.
Schroeder Brothers Corp.
Walworth Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, COMPRESSED-AIR
A. W. Cash Valve Mfg. Corp.
Clark Controller Co.
Cleco Div., Reed Roller Bit Co.
The Fairbanks Co.
Homestead Valve Mfg. Co.
C. B. Hunt & Son, Inc.—"QUICK-AS-WINK"
Jenkins Bros.
Le-Hi Div., Hose Accessories Co.
R. W. Nichols Co.—"MAC"
Pennsylvania Pump & Compressor Co.—"AIRCHECK," "GASCHECK"
Schroeder Brothers Corp.
Square D Co.
Walworth Co.
Welman Engineering Co., McDowell Enterprise

VALVES, COMPRESSED AIR UNLOADING
R. Conrader Co.—"CONRADER"

VALVES, CORROSION-RESISTANT
Electric Steel Foundry Co.
Homestead Valve Mfg. Co.

VALVES, CROSS
The Lunkenheimer Co.—"LUNKENHEIMER"

VALVES, DIAPHRAGM
The Bristol Co.—"SYNCHRO-VALVES"
A. W. Cash Co.
A. W. Cash Valve Mfg. Corp.
The Duriron Co., Inc.
Farris Flexible Valve Corp.
Fischer & Porter Co.
Foxboro Co.
Grinnell Co., Inc.—"GRINNELL - SAUNDERS"
Minneapolis - Honeywell Regulator Co., Industrial Division
Square D Co.
J. A. Zurn Mfg. Co.—"ZURN"

VALVES, FLOAT
Fischer & Porter Co.
Square D Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, FOOT
Crane Co.
Flood City Brass & Electric Co.
Ledeen Mfg. Co.
Ludlow Valve Mfg. Co., Inc.
Midland Pipe & Supply Co.
Walworth Co.

VALVES, GATE
American Brake Shoe Co., Amsco Div.—"AMSCO"
Crane Co.
Detroit Controls Corp., D. T. Williams Valves
Electric Steel Foundry Co.
The Fairbanks Co.
Fischer & Porter Co.
Guyan Machy. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
Ludlow Valve Mfg. Co., Inc.
The Lunkenheimer Co.—"BREECH-LOCK," "CAUSUL," "KING-CLIP"
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Stephens-Adamson Mfg. Co.—"TWISTITE"
Walworth Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, GATE, REPAIRED
Leman Machine Co.

VALVES, GLOBE
Crane Co.
Detroit Controls Corp., D. T. Williams Valves
Electric Steel Foundry Co.
The Fairbanks Co.
Guyan Machy. Co.
Jenkins Bros.
Kennedy Valve Mfg. Co.
The Lunkenheimer Co.—"FERRENEWO," "LQ600," "N-M-D," "RENEWO"
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Walworth Co.
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, GLOBE, REPAIRED
Leman Machine Co.

VALVES, LUBRICATED
Homestead Valve Mfg. Co.
Walworth Co.

VALVES, MOTOR-OPERATED
The Bristol Co.
Convair
Electric Steel Foundry Co.
Farris Flexible Valve Corp.
Fischer & Porter Co.
Foxboro Co.
Homestead Valve Mfg. Co.
Kennedy Valve Mfg. Co.
S. P. Kinney Engineers, Inc.
Ludlow Valve Mfg. Co., Inc.
Midland Pipe & Supply Co.
Minneapolis - Honeywell Regulator Co., Industrial Division
Philadelphia Gear Works—"LIMITORQUE"
R-P & C Valve Div., American Chain & Cable Co., Inc.
Rockwell Mfg. Co.—"ROCK-WELL-NORDSTROM"
Walworth Co.
Western Precipitation Corp.—"TYPE R-1," "FLOATING-SEAL"
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, NEEDLE
Detroit Controls Corp., D. T. Williams Valves
The Fairbanks Co.
Midland Pipe & Supply Co.
R. W. Nichols Co.—"PNEU-TROL GENERANT"
Ohio Brass Co.
R-P & C Valve Div., American Chain & Cable Co., Inc.
Schroeder Brothers Corp.
Walworth Co.

VALVES, PINCH
The Daniels Co., Contractors, Inc.
Farris Flexible Valve Corp.
Linatex Corp. of America
Red Jacket Co., Inc.—"RED JACKET"

VALVES, PLASTIC
The Lunkenheimer Co.—"LUNCOR"

VALVES, PLUG
Ampco Metal, Inc.
American Car & Foundry Div., ACF Industries, Inc.
Barrett, Haentjens & Co.
Convair
The Duriron Co., Inc.
Homestead Valve Mfg. Co.
S. P. Kinney Engineers, Inc.
Ludlow Valve Mfg. Co., Inc.
McNally-Pittsburg Mfg. Corp.
Midland Pipe & Supply Co.
Minneapolis - Honeywell Regulator Co., Industrial Division
Rockwell Mfg. Co.—"ROCK-WELL," "NORDSTROM"
J. Z. Zurn Mfg. Co.—"ZURN"

VALVES, POWER-OPERATED
Ledeen Mfg. Co.

VALVES, PUMP
American Brake Shoe Co., Amsco Div.—"AMSCO"
Anchor Packing Co.
Denison Engineering Div., American Brake Shoe Co.
Electric Steel Foundry Co.
New York Belting & Packing Co.—"N Y B & P," "GREAT SEAL"

VALVES, SAFETY
A. W. Cash Valve Mfg. Corp.

VALVES, STAINLESS-STEEL
Electric Steel Foundry Co.

VARNISHES, INSULATING
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section—"GLYPTAL"
Jeffrey Mfg. Co.
Martindale Electric Co.
Minnesota Mining & Mfg. Co., Irvington Div.
National Mine Service Co.
Pennsylvania Electric Coil Corp.

VENTILATING, TUBING
American Brattice Cloth Corp.
Bemis Bro. Bag Co.—"FLEXIPIPE"
Flexaust Co.—"PORTOVENT"

VENTILATION SURVEYING EQUIPMENT

American Paulin System—"MICRO," "TERRA"

VIBRATION ABSORBERS

Cobra Metal Hose, Div. DK Mfg. Co.

VIBRATION DAMPERS, RUBBER

Goodyear Tire & Rubber Co.
Raybestos Manhattan, Inc., Manhattan Rubber Div.

VIBRATION MEASUREMENT, BLASTING

W. F. Sprengnether Instrument Co., Inc.
Vibration Measurement Engineers, Inc. — "SEISMOLOG"

VIBRATORS, BIN & HOPPER

Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Eriez Manufacturing Co.
Hewitt-Robins Incorporated
Martin Engineering Co.—"VIBROLATOR"
Syntron Co.—"PULSATING MAGNET"
W. S. Tyler Co.—"TY-SPEED"

VIBRATORS, CHUTE

Branford Co.—"BRANFORD"
Cleveland Vibrator Co.
Martin Engineering Co.—"VIBROLATOR"
Syntron Co.—"PULSATING MAGNET"
W. S. Tyler Co.

VIBRATORS, FREIGHT CAR

Martin Engineering Co.

VOLTMETERS, INDICATING

General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Martindale Electric Co.
Westinghouse Electric Corp.

VOLTMETERS, RECORDING

The Bristol Co.—"BRISTOL'S"
General Electric Co., Apparatus Sales Div.
Graybar Elec. Co., Inc.
Westinghouse Electric Corp.

WAGONS, HAULING

Allis-Chalmers Mfg. Co., Construction Machinery Div.
Allis-Chalmers Mfg. Co., Industrial Equipment Div.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

WALLS, SUSPENDED FURNACE

Bigelow-Liptak Corp.

WARNING SIGNALS

American Mine Door Co.
Crouse-Hinds Co.
Graybar Elec. Co., Inc.
Nachod & U. S. Signal Co.

WASHABILITY TESTS

The Daniels Co. Contractors, Inc.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Warner Laboratories

WASHERS, AIR

American Blower, Div. of American-Standard

WASHERS, CALCIUM-CHLORIDE

Fuel Process Co.
Kanawha Mfg. Co.

WASHERS, HEAVY-MEDIA

The Daniels Co., Contractors, Inc.—"DMS"
Nelson L. Davis Co.—"NELDCO"
Fairmount Machinery Co.
Fuel Process Co.
Hewitt - Robins Incorporated,—"ELIPTEX"
Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57 —"FLOAT-SINK"
McNally-Pittsburg Mfg. Corp.—"McNALLY TROMP"
The Ore & Chemical Corp.—"OCC VESSEL"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Smith Engineering Works
Western Machinery Co.—"WEMCO"
Wilmot Engineering Co.

WASHERS, JIG

Jeffrey Mfg. Co.
Kanawha Mfg. Co.
Link-Belt Co., Dept. CAMGL-57
McNally-Pittsburg Mfg. Corp. —"McNALLY MOGUL," "McNALLY NORTON"
Ore Reclamation Co.
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

WASHERS, LAUNDER, TROUGH

The Daniels Co., Contractors, Inc.—"DMS"
Link-Belt Co., Dept. CAMGL-57
K. Prins & Associates—"PRINS"
Roberts & Schaefer Co., Sub. Thompson-Starrett Co. Inc.
Wilmot Engineering Co.

WASHERS, SAND-FLOTATION

Fairmont Machinery Co.
Universal Road Machinery Co.

WASHERS, SCREW

Eagle Iron Works
Link-Belt Co., Dept. CAMGL-57
McLanahan & Stone Corp.

WASHERS, STEEL

St. Louis Screw & Bolt Co.

WASHERS, UPWARD-CURRENT

Eagle Iron Works
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.
Wilmot Engineering Co.

WATER NEUTRALIZERS

American Minechem Co.
American Well Works
The Permutit Co.

WATER-RECLAMATION SYSTEMS

Bird Machine Co.
Bulkley, Dunton Processes, Inc.
Dorr-Oliver, Inc.
Kanawha Mfg. Co.
Kling Bros. Engineering Works —"KLING," "ROTARY STRAINER"
Link-Belt Co., Dept. CAMGL-57
The Permutit Co.
K. Prins & Associates
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc.

WATER REPELLENTS

American Minechem Co.
Dow Corning Corp.
E. I. du Pont de Nemours & Co., Inc.
Sika Chemical Corp.
Stonhard Co.—"STONTITE," "STONSEAL"

WATER SOFTENERS, DEMINERALIZERS

The Permutit Co.

WATER SYSTEMS, DOMESTIC

Barnes Mfg. Co.

WATER-TREATMENT EQUIPMENT

B-I-F Industries, Inc.

WATTMETERS, CLAMP-ON

Martindale Electric Co.

WEARING PLATES

American Brake Shoe Co., Amsco Div.

WEDGE BARS, TOOTH REPOINTING

American Brake Shoe Co., Amsco Div.
Stulz-Sickles Co.—"MANAGNAL"

WEDGE BARS, TOOTH REPOINTING, MANGANESE

Kensington Steel, Div. of Poor & Co.

WEDGES, CONE

Leetonia Tool Co.

WELDERS, ARC

Air Reduction Sales Co. A Div. of Air Reduction Co., Inc.
Caterpillar Tractor Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Electric Co.—"SHIELD-ARC," "IDEAL-ARC," "FLEET-WELDER," "LINC-WELDER," "LINCOLN-WELD"
Marathon Coal Bit Co., Inc.—"AIRCO"
Metal & Thermit Corp.—"M & T"
Mosebach Electric & Supply Co.
Penn Machine Co.
Westinghouse Electric Corp.

WELDERS POSITIONERS

Harnischfeger Corp.
The Sight Feed Generator Co.—"REXARC"

WELDERS, RAIL BONDING

Erico Products, Inc.—"CADWELD"
Flood City Brass & Electric Co.
Guyan Machy. Co.—"GUYAN"
Ohio Brass Co.
Penn Machine Co.
The Post Glover Electric Co.—"P-G"

WELDERS, RECTIFIER

Harnischfeger Corp.

WELDERS, TRANSFORMER

Harnischfeger Corp.

WELDING ACCESSORIES

A. O. Smith Corp.

WELDING CABLE

Collyer Insulated Wire Co.
Cornish Wire Co., Inc.
Gar Wood Industries, Inc.
General Cable Corp.
Guyan Machy. Co.
Hobart Bros. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Lincoln Electric Co.—"STABLE-ARC," "LINCOLNDUCTOR"
Marathon Coal Bit Co., Inc.—"AIRCO"
National Electric Products Co.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.
Rome Cable Corp.
Tweco Products, Inc.—"TWECO LITE"
Victor Equipment Co.

WELDING CARBON PRODUCTS

Helwig Co.
Marathon Coal Bit Co., Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Co.
Ohio Carbon Co.
Stackpole Carbon Co.

WELDING, CUTTING TORCHES, OUTFITS

Air Reduction Sales Co. A Div. of Air Reduction Co., Inc.
General Scientific Equipment Co.
Marathon Coal Bit Co., Inc.—"AIRCO"
Victor Equipment Co.

WELDING-ELECTRODE HOLDERS

Air Reduction Sales Co. A Div. of Air Reduction Co., Inc.
Erico Products, Inc.—"CADDY"
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.—"JACKSON"
Hobart Bros. Co.
Lincoln Electric Co.—"COOLTONG," "INS," "HT," "T"
Mosebach Electric & Supply Co.
Tweco Products, Inc.—"TWECOTONG"

WELDING ELECTRODES AND GAS WELDING WIRE

Page Steel & Wire Div., American Chain & Cable Co., Inc.

WELDING ELECTRODES

Alloy Rods Co.—"ATOM ARC," "ARCALOG," "TOOLARC," "NICKEL ARC," "BRONZE ARC," "MANG-ARC'
Ampco Metal, Inc.—"AMPCO TRODE," "PHOS-TRODE," "MANG-TRODE," "AMPCO-BRAZ"
Crucible Steel Co. of America—"REZISTAL," "STAINLESS,"
Eutectic Welding Alloys Corp.—"BRONZOCHROM" "CASTOLIN EUTECTIC," "CUT TRODE," "EUTECHROM," "EUTEC-ROD," "EUTECTIC LOW TEMPERATURE WELDING ALLOYS," "EUTEC STAINROD," "EUTEC BRAZE," "FLOTECTIC," "FRIGID ARC," "EUTEC HANDOMATIC," "STEELTECTIC," "TIN WELD," "WELDING ALLOYS," "EUTECTOR FLUX," "EUTECTRODE," "EUTECTOMASK," "EUTEC ALUMWELD," "EUTEC SILVER WELD," "EUTEC STAINTRODE," "ALUTIN," "AUTO CHEMIC," "CHAMFERTRODE," "COPWELD," "SIL WELD," "LOW AMP," "LOW TEMP." "NITECTIC," "UNIMATIC," "XYRON"
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Guyan Machy. Co.—"MUREX"
Harnischfeger Corp.
Hobart Bros. Co.
Lincoln Electric Co.—"JETWELD," "FLEETWELD," "SHIELD-ARC,' "STAINWELD," "ALUMINUMWELD,' "AERISWELD,' "FERRO-WELD," "PLANEWELD'
Marathon Coal Bit Co. Inc.—"AIRCO"
Metal & Thermit Corp.—"MUREX"
Mosebach Electric & Supply Co.
A. O. Smith Corp.
Stulz-Sickles Co.—"MANGANAL"
Taylor-Wharton Co. Div., Harsco Corp.—"TIMANG"
Victor Equipment Co.
Wall Colmonoy Corp.—"HARDFACING"
Westinghouse Electric Corp.

WELDING ELECTRODES, NICKEL, NICKEL ALLOY

International Nickel Co., Inc.

WELDING ELECTRODES, CARBON

Crucible Steel Co. of America—"STAINLESS"
Helwig Co.
Hobart Bros. Co.
Lincoln Electric Co.—"E321, "E882"
Marathon Coal Bit Co. Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Co.
Ohio Carbon Co.
Pure Carbon Co., Inc.
Stackpole Carbon Co.

WELDING ELECTRODES, GRAPHITE

Helwig Co.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
National Carbon Co., Div. of Union Carbide Co.
Ohio Carbon Co.
Stackpole Carbon Co.

WELDING EQUIPMENT, INERT GAS ARC

Air Reduction Sales Co., A Div. of Air Reduction Co. Inc.

WELDING EQUIPMENT, SEMIAUTOMATIC

A. O. Smith Corp.

WELDING FITTING & FLANGES

L. B. Foster Co.

WELDING-FLUX RECLAIMING SCREENS

Simplicity Engineering Co.

WELDING FLUXES

Eutectic Welding Alloys Corp.—"EUTECTOR FLUXES"
General Electric Co., Apparatus Sales Div.
Lincoln Electric Co.—"760," "780," "781," "840"
Marathon Coal Bit Co. Inc.—"AIRCO"
The Sight Feed Generator Co.
Victor Equipment Co.

WELDING GASES

Air Reduction Sales Co. A Div. Air Reduction Co., Inc.
Guyan Machy. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING GOGGLES

Air Reduction Sales Co., A Div. of Air Reduction Co., Inc.
American Optical Co.—"NOVIWELD," "DURAWELD"
Bausch & Lomb Optical Co.
E. D. Bullard Co.
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Guyan Machy. Co.
Hobart Bros. Co.
Marathon Coal Bit. Co. Inc.—"AIRCO"
Mine Safety Appliances Co.
Ore Reclamation Co.
Pulmosan Safety Equip. Co.
U. S. Safety Service Co.
Victor Equipment Co.
Willson Products Div., Ray-O-Vac Co.

WELDING GROUND CLAMPS

Albert & J. M. Anderson Mfg. Co.
Erico Products, Inc.—"CADDY"
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
Hobart Bros. Co.
Lincoln Electric Co.—"GC 300," "GC 400"
Marathon Coal Bit Co., Inc.—"AIRCO"
Ohio Brass Co.
Trico Fuse Mfg. Co.—"KLIPLOK"
Tweco Products, Inc.—"TWECO"
Victor Equipment Co.

WELDING HELMETS

American Optical Co.
E. D. Bullard Co.
Chicago Eye Shield Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Guyan Machy. Co.
Hobart Bros. Co.
Lincoln Electric Co.—"COMFORT SHIELD," "LPH,' "FMH"
Marathon Coal Bit Co. Inc.—"AIRCO"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
Westinghouse Electric Corp.
Willson Products Div. R,ay-O-Vac Co.

WELDING HOLDERS

Flood City Brass & Electric Co.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"

WELDING HOSE

Carlyle Rubber Co., Inc.
Goodyear Tire & Rubber Co.
Guyan Machy. Co.
Hamilton Rubber Mfg. Corp.—"STAPLE"
Hewitt-Robins Incorporated—"TWIN-WELD'
Industrial Rubber Products Co. (Pa.)
Marathon Coal Bit Co. Inc.—"AIRCO"
Raybestos Manhattan, Inc., Manhattan Rubber Div.
Thermoid Co.
Victor Equipment Co.

WELDING RECTIFIERS

General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
A. O. Smith Corp.

WELDING ROD, WIRE

American Brake Shoe Co., Amsco—"AMSCO"

WELDING SHIELDS

American Optical Co.
Flood City Brass & Electric Co.
General Electric Co., Apparatus Sales Div.
General Scientific Equipment Co.
Hobart Bros. Co.
Marathon Coal Bit Co. Inc.—"AIRCO"
Mine Safety Appliances Co.
Pulmosan Safety Equip. Co.
Westinghouse Electric Corp.

WELDING TRANSFORMERS

General Electric Co., Apparatus Sales Div.
General Nuclear Corp.
Guyan Machy. Co.—"M & J"
Hobart Bros. Co.
Lincoln Electric Co.—"IDEALARC," "FLEETWELDER"
Marathon Coal Bit Co. Inc.—"AIRCO"
A. O. Smith Corp.
Westinghouse Electric Co.

WELDING WIRE

Drawalloy Corp.—"DRAWALLOY"

WELDING WIRE, AUTOMATIC

The Sight Feed Generator Co.—"REXARC"

WELDMENTS

American Brake Shoe Co., Amsco Div.—"AMSCO"
American Car & Foundry Div., ACF Industries, Inc.
Bethlehem Steel Co.
Connellsville Mfg. & Mine Supply Co.
Falk Corp.
Farrel-Birmingham Co., Inc.
L. O. Koven & Bro., Inc.
The R. C. Mahon Co.
Meckum Engr. Co.
Phoenix Iron & Steel Co., Structural & Tube Divs.
Sanford Day Iron Works, Inc.
Welman Engineering Co., McDowell Enterprise

WELDMENTS, CAST

Electric Steel Foundry Co.

WETTING AGENTS

American Minechem Co.

WHEELBARROWS

The Wood Shovel & Tool Co.

WHEELBARROWS, POWERED

Prime Mover Co.—"15A"

WHEELS, LOCOMOTIVE, CAST-IRON

American Car & Foundry Div., ACF Industries, Inc.
Ironton Engine Co.—"IRONTON"
Irwin Foundry & Mine Car Co.
Kersey Manufacturing Co., Inc.

WHEELS, LOCOMOTIVE, STEEL

Bethlehem Steel Co.
Ironton Engine Co.—"IRONTON"
Pittsburgh Gear Co.
Sterling Steel Casting Co.

WHEELS, LOCOMOTIVE, STEEL, REBUILT

Leman Machine Co.

WHEELS, MACHINE-TRUCK

Irwin Foundry & Mine Car Co.
United States Rubber Co.

WHEELS, MINE-CAR, CAST-IRON

American Car & Foundry Div., ACF Industries, Inc.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Helmick Foundry-Machine Co.
Hockensmith Corp.
Irwin Foundry & Mine Car Co.
Kanawha Mfg. Co.
McLanahan & Stone Corp.
Sanford Day Iron Works, Inc.
Watt Car & Wheel Co.

WHEELS, MINE-CAR, MANGANESE

Kensington Steel, Div. of Poor & Co.

WHEELS, MINE-CAR, STEEL

American Brake Shoe Co., Amsco Div.—"AMSCO"
Bethlehem Steel Co.
C. S. Card Iron Works
Enterprise Wheel & Car Corp.
Gibraltar Equipment & Mfg. Co.
Irwin Foundry & Mine Car Co.
National Malleable & Steel Castings Co.—"NACO"
Sanford Day Iron Works, Inc.
Sterling Steel Casting Co.
Watt Car & Wheel Co.

WINCHES

Chicago Pneumatic Tool Co.
J. D. Christian Engineers
Clyde Iron Works, Inc.
Gar Wood Industries, Inc.
Indiana Foundry Co.
Ledeen Mfg. Co.
Mobile Drilling Inc.
Robbins & Meyers, Inc.—"R & M"
Sauerman Bros., Inc.
Shepard Niles Crane & Hoist Corp.
Stephens-Adamson Mfg. Co.
Vickers, Inc., Tulsa Winch Div.—"TULSA"

WINCHES, AIR

Joy Mfg. Co.

WINCHES, PIPE DRIVING

Sprague & Henwood

WINDOWS, INDUSTRIAL STEEL

Steelcraft Mfg. Co.

WIRE, ARMATURE BENDING, STAINLESS, CARBON STEEL

Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, ELECTRICAL—See Also Cable

WIRE, ELECTRICAL, BARE

American Steel & Wire—"TIGER BRAND"
Circle Wire & Cable Corp.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
General Cable Corp.
Graybar Elec. Co., Inc.
Phelps Dodge Copper Products Co.
Rome Cable Corp.

WIRE, ELECTRICAL, INSULATED

American Steel & Wire
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
Cornish Wire Co., Inc.
Ensign Electric & Mfg. Co.
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
National Electric Products Co.
National Mine Service Co.
Okonite Co.
Phelps Dodge Copper Products Co.
Reynolds Metals Co.
Rockbestos Products Corp.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Rome Cable Corp.
Simplex Wire & Cable Co.

WIRE, FEEDER

Aluminum Company of America
American Steel & Wire
Anaconda Wire & Cable Co.
Circle Wire & Cable Corp.
Collyer Insulated Wire Co.
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Joy Mfg. Co.
Kaiser Aluminum & Chemical Sales, Inc.
Mosebach Electric & Supply Co.
Phelps Dodge Copper Products Co.
Rome Cable Corp.

WIRE, SHAPED

Page Steel & Wire Div., American Chain & Cable Co., Inc.

WIRE, SHOTFIRING

American Steel & Wire
Circle Wire & Cable Corp.
Cornish Wire Co., Inc.
John Flocker & Co.
General Cable Corp.
Kaiser Aluminum & Chemical Sales, Inc.
King Powder Co., Inc.
National Mine Service Co.
Okonite Co.
Olin-Mathieson Chemical Corp., Explosives Div.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.
Rome Cable Corp.

WIRE, TELEPHONE

American Steel & Wire
Copperweld Steel Co., Wire & Cable Div.—"COPPERWELD"
John Flocker & Co.
General Cable Corp.
Graybar Elec. Co., Inc.
Kaiser Aluminum & Chemical Sales, Inc.
Page Steel & Wire Div., American Chain & Cable Co., Inc.—"ACCOALUMINIZED"
National Electric Products Co.
Okonite Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.

WIRE, THERMOCOUPLE

West Instrument Corp.

WIRE, TROLLEY

Aluminum Co. of America
American Steel & Wire
Anaconda Wire & Cable Co.
John Flocker & Co.
General Cable Corp.
Mosebach Electric & Supply Co.
National Mine Service Co.
Phelps Dodge Copper Products Co.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp.

WIRE CLOTH

Hoyt Wire Cloth Co.
Ludlow Saylor Wire Cloth Co.
W. S. Tyler Co.

WIRE ENAMELS

General Electric Co., Chemical & Metallurgical Div., Insulating Materials Section

WIRE ROPE, PLASTIC COATED

Rochester Ropes, Inc.

WIRE ROPE, STAINLESS, MONEL, PLASTIC COATED AND NYLON COATED

Macwhyte Co.

WIRE ROPE

American Chain & Cable—"LAY-SET," "TRU-LAY," "VHS"
American Steel & Wire
Bergen Wire Rope Co.
Bethlehem Steel Co.
Bowdil Co.
Broderick & Bascom Rope Co.—"YELLOW STRAND," "POWERSTEEL"
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.—"WICKWIRE"
John Flocker & Co.
Flood City Brass & Electric Co.
Guyan Machy Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"HERCULES RED STRAND," "PORTER IMPERIAL RED STRAND"
LeTourneau-Westinghouse Co.—"TOURNAROPE"
Macwhyte Co.
Marathon Coal Bit Co. Inc.—"BETHLEHEM," "MACWHYTE"
Mosebach Electric & Supply Co.
National Mine Service Co.
Ore Reclamation Co.
Rochester Ropes, Inc.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
W. J. Savage Co.
Union Wire Rope Corp.—"TUFFY"
Upson-Walton Co.
West Virginia Armature Co.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE CLAMPS

Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co. Inc.—"LEPRO"
Marathon Coal Bit Co. Inc.—"BETHLEHEM"
Mosebach Electric & Supply Co.
Ore Reclamation Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
Sauerman Bros., Inc.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE CLIPS

American Chain & Cable—"ACCO CLIPS"
American Logging Tool Corp.—"ALTCO"
Broderick & Bascom Rope Co.
Colorado Fuel & Iron Corp., Wickwire Spencer Steel Div.
Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY"
Ensign Electric & Mfg. Co.
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Co.
Marathon Coal Bit Co., Inc.—"BETHLEHEM"
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Joseph T. Ryerson & Son, Inc.
W. J. Savage Co.
Union Wire Rope Corp.
Upson-Walton Co.—"GOLD CLIP"
Wire Rope Corp. of Americ[illegible], Inc.—"WIRECO"

WIRE-ROPE DRESSING, LUBRICANTS

Ashland Oil & Refining Co.—

"ASHLAND"
Cities Service Oil Co.
Esso Standard Oil Co.—"SURETT"
John Flocker & Co.
Jesco Lubricants Co.
Jet-Lube, Inc.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co. Inc.—"LEPRO"
Macwhyte Co.
New York & New Jersey Lubricant Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Shell Oil Co.
Sun Oil Co.
Swan-Finch Petrochemicals—"AEROSOL"
The Texas Co.

WIRE-ROPE, CONDUCTOR-CORE

American Chain & Cable—"SIGNALKORE"

WIRE-ROPE EYES

American Chain & Cable
Crosby Laughlin Div., American Hoist & Derrick Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Joy Mfg. Co.
Leschen Wire Rope Div., H. K. Porter Co. Inc.—"LEPRO"
Macwhyte Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Union Wire Rope Corp.

WIRE-ROPE FITTINGS

Rochester Ropes, Inc.

WIRE-ROPE SHACKLES

American Chain & Cable
Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE SLINGS

Rochester Ropes, Inc.

WIRE-ROPE SOCKETS

American Chain & Cable
Bowdil Co.
Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Co.
Mosebach Electric & Supply Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Sauerman Bros., Inc.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE-ROPE SWAGED ASSEMBLIES

American Chain & Cable—"TRU-LOC"
Bethlehem Steel Co.
Broderick & Bascom Rope Co.—"BROLOC"
Crosby Laughlin Div., American Hoist & Derrick Co.
Electric Steel Foundry Co.
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
W. J. Savage Co.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, Inc.—"WIRCO"

WIRE-ROPE SWIVELS

Crosby Laughlin Div., American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Union Wire Rope Corp.
Upson-Walton Co.
Wire Rope Corp. of America, —"WIRECO"

WIRE-ROPE THIMBLES

Crosby Laughlin Div. American Hoist & Derrick Co.—"CROSBY," "LAUGHLIN"
John Flocker & Co.
Guyan Machy. Co.
Jones & Laughlin Steel Corp.
Leschen Wire Rope Div., H. K. Porter Co., Inc.—"LEPRO"
Macwhyte Co.
John A. Roebling's Sons Corp. Sub., Colorado Fuel & Iron Corp.
Upson-Walton Co.
Union Wire Rope Corp.
Wire Rope Corp. of America, Inc.—"WIRECO"

WIRE STRIPPERS

Martindale Electric Co.

WIREWAYS

Square D Co.

WIRING DEVICES

The Elreco Corp.
Graybar Elec. Co., Inc.
Holub Industries, Inc.
National Electric Products Co.

WOOD PRESERVATIVES

Darworth, Inc., Cuprinol Div.—"CUPRINOL"
The Dow Chemical Co.
T. J. Moss Tie Co.
Osmose Wood Preserving Co.—"OSMOSALTS," "OSMOPLASTIC," "M-T-M,"
Steelcote Mfg. Co.—"STEELCOTE," "COPPERITE," "ROT-PROOFING"

WRENCHES, BIT

Duquesne Mine Supply Co.
Guyan Machy. Co.
Joy Mfg. Co.
Leetonia Tool Co.
Marathon Coal Bit Co. Inc.—"MARATHON," "PROTO"
Frank Prox Company Inc.
Stardrill-Keystone Co.
Bertrand P. Tracy Co.

WRENCHES, HOPPER

Advance Car Mover Co., Inc.—"ADVANCE SAFETY"

WRENCHES, IMPACT

Black & Decker Mfg. Co.
Chicago Pneumatic Tool Co.
Cleco Div., Reed Roller Bit Co.
Gardner-Denver Company
Ingersoll-Rand Co.
Mall Tool Co.—"MALL," "REMINGTON"
Marathon Coal Bit Co. Inc.—"PROTO"
Penn Machine Co.
Schroeder Brothers Corp.
Snap-on Tools Corp.
Thor Power Tool Co.

WRENCHES, REVERSIBLE RATCHET

Greene, Tweed & Co.—"FAVORITE"

WRENCHES, SET SCREW

Leetonia Tool Co.

WRENCHES, TORQUE

Bearings, Inc.
Ingersoll-Rand Co.
Marathon Coal Bit Co. Inc.—"PROTO"
Schroeder Brothers Corp.
Snap-on Tools Corp.

WRENCHES, TRACK

Gibraltar Equipment & Mfg. Co.
Guyan Machy. Co.
Ingersoll-Rand Co.
Nordberg Mfg. Co.

YO-YOS, ELECTRIC

The Nolan Co.

YO-YOS, HYDRAULIC

The Nolan Co.
Schroeder Brothers Corp.
W. R. Stamler Corp.

YO-YOS, HYDRAULIC, REBUILT

Leman Machine Co.

Another Service of the 1957 Coal Age Mining Guidebook . . .

Beginning on the next page is the Directory of Manufacturers, arranged in alphabetical order, to help you quickly locate the address of the supplier of any equipment listed in this Buying Directory. Following the Directory of Manufacturers is a listing of local distributors of the products advertised in this issue.

Coal Age Directory of

Black-faced type indicates a product-information advertisement in this issue.

A

Acker Drill Co., Inc., 725 West Lackawanna Ave., Scranton, Pa.
Acme Machinery Co., P. O. Box 1169, Williamson, West Va.
Advance Car Mover Co., Inc., Box 536, Appleton, Wis.
Aerial Surveys, Inc., 4614 Prospect Ave., Cleveland, Ohio
Aero Service Corp., 210 East Courtland St., Philadelphia 20, Pa.
Aeroquip Corp., Jackson Div., 300 S. East Ave., Jackson, Mich. ADV. p 286
Ahlberg Bearing Co., 3025 West 47 St., Chicago 32, Ill.
Air Reduction Sales Co., A Div. of Air Reduction Co., Inc., 150 East 42nd Street, New York 17, N. Y.
Airmite-Midwest Inc., 119 North Chestnut St., DuQuoin, Ill.
Ajax Flexible Coupling Co., Inc., 100 English St., Westfield, N. Y. ADV. p 230
Aldon Co., 3338 Ravenswood Ave., Chicago 13, Ill., ADV. p 278
Aldrich Pump Co., 1 Pine St., Allentown, Pa.
Alford, Newell G., 509 Oliver Bldg., Pittsburgh 22, Pa.
Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh 22, Pa., ADV. p 10
Allen & Garcia Co., 332 South Michigan Ave., Chicago 4, Ill., ADV. p. 288
Allen-Sherman-Hoff Pump Co., 259 East Lancaster Ave., Wynnewood, Pa.
Allis-Chalmers Mfg. Co., Buda Div., 1135 S. 70th St., Milwaukee 1, Wis.
Allis-Chalmers Mfg. Co., Construction Machinery Div., Box 512, Milwaukee 1, Wis.
Allis-Chalmers Mfg. Co., Industrial Equipment Div., 968 South 70 St., Milwaukee 1, Wis., ADV Insert pp 16-17
The Louis Allis Co., 427 East Stewart St., Milwaukee 1, Wis.
Allison Div., American Chain & Cable Co., Inc., 257 Island Brook Ave., Bridgeport 8, Conn.
Allison Div., General Motors Corp., 4700 W. 10th St., Indianapolis, Ind.
Alloy Rods Co., York, Pa.
Alpha Molykote Corp., 65 Harvard St., Stamford, Conn.
Aluminum Company of America, 1501 Alcoa Bldg., Pittsburgh 19, Pa.
American Air Filter Co., Inc., 267 Central Ave., Louisville 8, Ky., ADV. p 234
American Air Surveys, Inc., 907 Penn Ave., Pittsburgh 22, Pa.
American Blower Corp., Div. of American-Standard, Detroit 32, Mich.
American Brake Shoe Co., American Brakeblok Div., 4600 Merria Ave., Detroit 9, Mich.
American Brake Shoe Co., Amsco Div., 230 Park Ave., New York 17, N. Y.
American Brake Shoe Co., National Bearing Div., 4930 Manchester Ave., St. Louis 10, Mo.
American Brake Shoe Co., Railroad Products Div., 530 Fifth Ave., New York 36, N. Y.
American Brattice Cloth Corp., Warsaw, Ind.
American Car & Foundry Div., ACF Industries, Inc., 30 Church St., New York 8, N. Y., ADV. p 9
American Chain & Cable, Wilkes Barre, Pa.
American Chain & Cable Co., Inc., American Chain Div., E. Princess & Charles Sts., York, Pa.
American Conveyor Co., 2133 South Christiana, Chicago, Ill.
American Crucible Products Co., Oberlin Rd., Lorain, Ohio
American Cyanamid Co., Explosives Dept., 30 Rockefeller Plaza, New York 20, N. Y. ADV. p 205
American Cyanamid Co., Mining Chemicals Dept., 30 Rockefeller Plaza, New York 20, N. Y.
American Engineering Co., Wheatsheaf Lane & Sepviva St., Philadelphia 37, Pa.
American Flexible Coupling Div., Zurn Industries, Inc., 1960 Pittsburgh Ave., Erie, Pa.
American Hoist & Derrick Co., 63 South Robert St., St. Paul 7, Minn.
American LaFrance Corp., 160 East LaFrance St., Elmira, N. Y.
American Logging Tool Corp., Sub. of Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.
American-Marsh Pumps, Inc., 59 Capitol Ave., N. E., Battle Creek, Mich.
American Mine Door Co., 2057 Dueber Ave., S. W., Canton 6, Ohio, ADV. p 219
American Mine Supply Co., 404 Frick Bldg., Pittsburgh 19, Pa., ADV. p 240
American Minechem Co., 641 Fourth Ave., Coraopolis, Pa.
The American Oil Co., 555 Fifth Ave., New York 17, N. Y.
American Optical Co., 14 Mechanic St., Southbridge, Mass.
American Paulin System, 1524 South Flower St., Los Angeles 15, Calif.
The American Pulley Co., 4200 Wissahickon Ave., Philadelphia 29, Pa.
American Pulverizer Co., 1249 Macklind Ave., St. Louis 10, Mo., ADV. p 273
American Steel Foundries, Prudential Plaza, Chicago 1, Ill.
American Steel & Wire, 842 Rockefeller Bldg., Cleveland 13, Ohio, ADV. p 202-203
American Well Works, 100 North Broadway, Aurora, Ill.
O. Ames Co., Camden Ave., Parkersburg, West Va.
Jack Ammann Photogrammetric Engineers, Inc., 931 Broadway, San Antonio 5, Texas
Ampco Metal, Inc., 1723 South 38 St., Milwaukee, Wis.
Anaconda Wire & Cable Co., 25 Broadway, New York 4, N. Y. ADV. p 233
Analytical Measurements, Inc., 585 Main St., Chatham, N. J.
Anchor Coupling Co., Inc., 340 N. Fourth St., Libertyville, Ill.
Anchor Packing Co., 401 North Broad St., Philadelphia 8, Pa.
Albert & J. M. Anderson Mfg. Co., 289 A St., Boston 10, Mass.
The Ansonia Wire & Cable Co., 111 Martin St., Ashton, R. I.
Ansul Chemical Co., Marinette, Wis.
Armco Drainage & Metal Prod., Inc., Middletown, Ohio
Armstrong-Bray & Co., 5364 Northwest Hwy., Chicago 30, Ill.
Arrow Hart & Hegeman Electric Co., 103 Hawthorne St., Hartford 6, Conn.
Arrowhead Steel Buildings, Inc., 1122 W. Railroad St., Duluth 6, Minn.
Ashland Oil & Refining Co., Ashland, Ky.
Athey Products Corp., 5631 W. 65 St., Chicago 38, Ill. ADV. p 241
Atlas Powder Co., Concord Pike & Murphy Rd., Wilmington 98, Del. ADV. p 265
Auburn Foundry, Inc., Heating Div., Auburn, Indiana
Aurora Pump Div., The New York Air Brake Co., 100 Loucks St., Aurora, Ill.
Austin Powder Co., Rockefeller Bldg., Cleveland 13, Ohio ADV. p 246
Austin-Western Works, Construction Equipment Div., Baldwin - Lima - Hamilton Corp., 601 N. Farnsworth Ave., Aurora, Ill. ADV. p 239
Axeman-Anderson Co., 223 West St., Williamsport 3, Pa.

B

Babcock & Wilcox Co., 161 East 42 St., New York 17, N. Y.
Baldwin-Lima-Hamilton Corp., Construction Equipment Div., South Main St., Lima, Ohio
Bantam Bearings Div., Torrington Co., 3702 West Sample St. South Bend 21, Ind.
Barber-Greene Co., 400 N. Highland Ave., Aurora, Ill.
Barnes Mfg. Co., 615 N. Main St., Mansfield, Ohio
Barrett, Haentjens & Co., Hazleton, Pa.
Baton & Co., Geo. S., 100 Union Trust Bldg., Pittsburgh 19, Pa.
Baughman Mfg. Co., Inc., Shipman Rd., Jerseyville, Ill.
Bausch & Lomb Optical Co., 804 St. Paul St., Rochester 2, N. Y.
Bay City Shovels, Inc., Bay City, Mich.

Manufacturers

Page number or numbers are given following the address in each such instance.

Bearing Service Co., 4650-52 Baum Blvd., Pittsburgh 13, Pa.
Bearings, Inc., 3634 Euclid Ave., Cleveland, Ohio
Beaver Pipe Tools Inc., 310 Dana Ave., S. E., Warren, Ohio
Bemis Bro. Bag Co., 408-10 Pine St., St. Louis 2, Mo.
Bergen Wire Rope Co., 151 Gregg St., Lodi, N. J.
C. L. Berger & Sons, Inc., 37 Williams St., Roxbury 19, Mass.
Bete Fog Nozzle, Inc., 309 Wells St., Greenfield, Mass.
Bethlehem Steel Co., 701 East Third St., Bethlehem, Pa.
B-I-F Industries, Inc., 345 Harris Ave., Providence, R. I., ADV. p 236
Bigelow-Liptak Corp., 13300 Puritan Ave., Detroit 27, Mich.
Bin-Dicator Co., 13946 Kercheval St., Detroit 15, Mich., ADV. p 278
Bird Machine Co., South Walpole, Mass.
Bituminous Casualty Corp., Bituminous Bldg., 320 18th St., Rock Island, Ill.
Bixby-Zimmer Engineering Co., 961 Abington St., Galesburg, Ill., ADV. p 214
Black & Decker Mfg. Co., 600 E. Pennsylvania Ave., Towson, Md.
Black Diamond Spad Co., 2108 Stratford Rd., Richmond 25, Va.
Blackhawk Mfg. Co., 5325 Rogers Ave., Milwaukee, Wis.
Blaw-Knox Co., Blaw-Knox Bldg., 300 Sixth Ave., Pittsburgh 22, Pa.
Bonded Scale & Machine Co., 17 Bellview, Columbus 7, Ohio
Boston Woven Hose & Rubber Co., P. O. Box 1071, Boston 3, Mass.
Bowdil Co., Boylan Ave., S. E., Canton, Ohio, ADV. p 271
The Branford Co., 131 Chestnut St., New Haven 7, Conn.
The Bristol Co., P. O. Box 1790 CA Waterbury 20, Conn.
Broderick & Bascom Rope Co., 4203 Union Blvd., St. Louis 15, Mo.
The Brooks Oil Co., 928 Ridge Ave., Pittsburgh 12, Pa.
Brookville Locomotive Works, Steele Blvd., Brookville, Pa.
Browning Dust Collector Co., P. O. Box 133, Hampden, W. Va.
Browning Mfg. Co., Maysville, Ky.
Charles Bruning Co., Inc., 4700 Montrose Ave., Chicago 41, Ill.
Brunner & Lay, Inc., 9300 King St., Franklin Park, Ill.
Brunner & Lay Rock Bit of Philadelphia Inc., 2514 East Cumberland St., Philadelphia 25, Pa.
Brunson Instrument Co., 1405 Walnut St., Kansas City, Mo.
Bucyrus-Erie Co., South Milwaukee, Wis.
Buffalo Forge Co., 490 Broadway, Buffalo 5, N. Y.
Buffalo Scale Co., Inc., 46 Letchworth St., Buffalo 13, N. Y.
Bulkley, Dunton Processes, Inc., 295 Madison Ave., New York 17, N. Y.
E. D. Bullard Co., 2680 Bridgeway, Sausalito, Calif.
Burndy Corp., Post Rd., Norwalk, Conn.
Bussmann Mfg. Co., 2536 W. University St., St. Louis 7 Mo.
Butler Mfg. Co., 7400 East 13th St., Kansas City 26, Mo.
Buttner Works, Inc., 52 Vanderbilt Ave., New York 17, N. Y. ADV. p 261
A. M. Byers Co., Clark Bldg., Pittsburgh 22, Pa.
Byron Jackson Pumps Inc., A Sub. of Borg-Warner Corp., P. O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

C

C & D Batteries, Inc., Conshohocken, Pa.
Samuel Cabot, Inc., 141 Milk St., Boston 9, Mass.
Cambridge Wire Cloth, Cambridge, Md.
E. K. Campbell Co., 1809 Manchester Ave., Kansas City 26, Mo.
Canton Stoker Corp., 741 Andrew Place, S. W. Canton, Ohio
C. S. Card Iron Works, P. O. Box 117, Denver 1, Colo.
Cardox Corp., 307 North Michigan Ave., Chicago 1, Ill., ADV. pp 224-225
Philip Carey Mfg. Co., Lockland, Cincinnati 15, Ohio
Carlon Products Corp., 10225 Meech Ave., Cleveland 5, Ohio
Carlyle Rubber Co., Inc., 103-107 Warren St., New York 7, N. Y.
Carolina Tire Co., 232 N. Main St., Salisbury, N. C.
Carpenter Heating & Air Conditioning Co., 2135 St. Clair Ave., Cleveland, Ohio
Carver Pump Co., Muscatine, Iowa
J. I. Case Co., 700 State St., Racine, Wis.
A. W. Cash Co., P. O. Box 551, Decatur, Ill.
A. W. Cash Valve Mfg. Corp., 666 E. Wabash, Decatur, Ill.
Castanoli, Alder F., 1302 W. Va. Bldg., Huntington, W. Va.
Caterpillar Tractor Co., Peoria 8, Ill.
Cement Gun Co., 1520 Walnut St., Allentown, Pa.
Central Mine Equipment Co., 6200 N. Broadway, St. Louis 15, Mo.
Central Scientific Co., 1700 Irving Park Blvd., Chicago 13, Ill.
Centric Clutch Co., P. O. Box 175, Woodbridge, N. J.
Centrifugal & Mech. Industries, Inc., 146 President St., St. Louis 18, Mo., ADV. p 248
Century Electric Co., 1806 Pine St., St. Louis 3, Mo.
Chain Belt Co., 4786 W. Greenfield Ave., Milwaukee 1, Wis.
Chain Belt Co., Shafer Bearing Div., P. O. Box 57, Downers Grove, Ill.
Cheatham Elec. Switching Device Co., 4780 Crittenden Dr., Louisville 9, Ky., ADV. p 240
Chelsea Fan and Blower Co., Inc., 639 South Ave., Plainfield, N. J.
Chevrolet Motor Div., General Motors Bldg., Detroit 2, Mich.
Chicago Eye Shield Co., 2304 Warren Blvd., Chicago, Ill.
Chicago Perforating Co., 2445 West 24 Pl., Chicago 8, Ill.
Chicago Pneumatic Tool Co., 6 East 44 St., New York, N. Y. ADV. p 204
Chiksan Co., 330 N. Pomona Ave., Brea, Calif.
J. D. Christian Engineers, 480 Potrero Ave., San Francisco 10, Calif.
The Cincinnati Electrical Tool Co., 360 Mt. Hope Ave., Cincinnati 4, Ohio
Cincinnati Mine Machinery Co., 2980 Spring Grove Ave., Cincinnati 25, Ohio, ADV. p 255
Cincinnati Rubber Mfg. Co., Div. of Thor Power Tool Co., Franklin Ave., Cincinnati 12, Ohio
Circle Wire & Cable Corp., 5500 Maspeth Ave., Maspeth, Long Island, N. Y.
Circuit Protective Devices Dept., General Electric Co., 41 Woodford Ave., Plainville, Conn.
Cities Service Oil Co., 60 Wall Tower, New York 5, N. Y.
Clarage Fan Co., 619 Porter St., Kalamazoo 16, Mich.
Clark Controller Co., 1146 E. 152nd St., Cleveland, Ohio
Clark Equipment Co., Construction Machinery Div., P. O. Box 599, Benton Harbor, Mich.
Clark Equip. Co., Automotive Div., Buchanan, Mich.
Cleco Div., Reed Roller Bit Co., P. O. Box 2119, Houston 1, Texas
Cleveland Vibrator Co., 2828 Clinton Ave., Cleveland, Ohio
Cleveland Wire Cloth & Mfg. Co., 3573 E. 78th St., Cleveland 5, Ohio
Cleveland Worm & Gear Co., 3249 East 80 St., Cleveland 4, Ohio
Clyde Iron Works, Inc., Duluth, Minn.
Coast Metals, Inc., Redneck Ave., Little Ferry, N. J.
Cobra Metal Hose, Div., DK Mfg. Co., 4640 W. 54th St., Chicago 32, Ill.
Coffing Hoist Div., Duff-Norton Co., 800 Walter St., Danville, Ill.
Collyer Insulated Wire Co., 249 Roosevelt Ave., Pawtucket, R. I.
Colorado Fuel & Iron Corp., Continental Oil Bldg., Denver Colo. Wickwire Spencer Steel Div., 575 Madison Ave., New

York 22, N. Y.
Colorado Iron Works Co., a sub. of Mine & Smelter Supply Co., 3800 Race St., P. O. Box 9041, Denver 16, Colo.
Columbia-Southern Chemical Corp., One Gateway Center, Pittsburgh 22, Pa.
Combustion Engineering, Inc., 200 Madison Ave., New York 16, N. Y.
Combustion Engineering, Inc., Raymond Div., 1319 N. Branch St., Chicago, Ill., ADV. p 287
The Commercial Shearing & Stamping Co., 1775 Logan Ave., Youngstown, Ohio
Commercial Testing & Engineering Co., 228 North LaSalle St., Chicago, Ill.
Compton, Inc., P. O. Box 1946, Clarksburg, W. Va., ADV p 215
Cone-Drive Gears Div, Michigan Tool Co., 7171 E. McNichols Rd., Detroit 12, Mich.
Connellsville Mfg. & Mine Supply Co., Connellsville, Pa.
Concordia Electric Co., 1521 Saw Mill Run Blvd., Pittsburgh 10, Pa.
R. Conrader Co., 236 West 17th St., Erie, Pa.
Construction Machy. Co., Box 120, Waterloo, Iowa
Continental Gin Co., Birmingham, Ala.
Continental Motors Corp., 205 Market St., Muskegon, Mich.
Continental Rubber Works, 1933 Liberty St., Erie 6, Pa.
Convair, P. O. Box 9671, Pittsburgh 26, Pa.
Copperweld Steel Co., Wire & Cable Div., Glassport, Pa.
Coppus Engineering Corp., 344 Park Ave., Worcester 10, Mass.
Corhart Refractories Co., 1600 West Lee St., Louisville, Ky.
Cornell-Dubilier Electric Corp., South Plainfield, N. J.
Cornish Wire Co., Inc., 50 Church St., New York 7, N. Y.
Cowin & Co., Inc., 1 18th St., SW, Birmingham, Ala.
Cox & Stevens Electronic Scales Div., Revere Corp. of America, Wallingford, Conn.
Crane Co., 836 S. Michigan Ave., Chicago 5, Ill.
Crescent Belt Fastener Co., 480 Lexington Ave., New York, N. Y.
Crosby Laughlin Div., American Hoist & Derrick Co., Fort Wayne 1, Ind.
Crouse-Hinds Co., Syracuse 1, N. Y.
Crucible Steel Co. of America, Henry W. Oliver Bldg., Mellon Sq., Pittsburgh 22, Pa.
Cummins Engine Co., 1138 Fifth St., Columbus, Ind.
Cutler-Hammer, Inc., 220 N. 12th St., Milwaukee 1, Wis.
Cutter Bit Service Co., 111 West 8th Ave., P. O. Box 533, Huntington, W. Va.

D

D-A Lubricant Co., Inc., 1331 West 29 St., Indianapolis 23, Ind.
Dallas Engineers, Inc., Coal-O-Matic Div., Main St., Trucksville, Pa.
The Daly Ticket Co., 506-08 Vandalia St., Collinsville, Ill.
The Dana Fan & Blower Corp., 2644 Colerain Ave., Cincinnati 14, Ohio
C. R. Daniels Co., Daniels, Md.
The Daniels Co., Contractors, Inc., 32 North Fifth St., Indiana, Pa., ADV. p 11
Dart Truck Co., 2623 Oak St., Kansas City 8, Mo., ADV. p 247
Darworth, Inc., Cuprinol Div., Simsbury, Conn.
Davey Compressor Co., 600 Franklin Ave., Kent, Ohio
Nelson L. Davis Co., 517 Main St., McHenry, Ill.
Day-Ray Products, Inc., 1133 Mission St., South Pasadena, Calif.
Dayton Automatic Stoker Co., 30 Deeds Ave., P. O. Box 174, North Dayton Station, Dayton, Ohio
Dayton Rubber Co., 2342 West Riverview Ave., Dayton 1, Ohio
Dean Brothers Pumps Inc., 323 West Tenth St., Indianapolis 7, Ind.
Deister Concentrator Co., 901 Glasgow Ave., Ft. Wayne 1, Ind.
Deister Machine Co., 1933 E. Wayne St., Ft. Wayne 4, Ind.
Delta-Star Electric Div., H. K. Porter Co. (Delaware), 2437 Fulton St., Chicago 12, Ill.
The Deming Co., Salem, Ohio
Denison Engineering Div., American Brake Shoe Co., 1160 Dublin Rd., Columbus 16, Ohio
Denver Equipment Co., P. O. Box 5268, Denver 17, Colo., ADV. p 242
Detroit Diesel Engine Div., General Motors Corp., 13400 West Outer Drive, Detroit 28, Mich.
Detroit Controls Corp., D. T. Williams Valves, Bridgeport 1, Conn.
Diamond Chain Co., Inc., 402 Kentucky Ave., Indianapolis 7, Ind.
Diamond Crystal Salt Co., St. Clair, Mich.
Diamond Iron Works, Div. Goodman Mfg. Co., Halsted St. & 48th Pl., Chicago 9, Ill.
Diamond Power Specialty Co., Lancaster, Ohio
Diehl Mfg. Co., 1208 Finderne Ave., Somerville, N. J.
Diesel Energy Corp., 82 Beaver St., New York, N. Y.
Differential Steel Car Co., Differential Ave., Findlay, Ohio.
Dings Magnetic Separator Co., 4724 W. Electric Ave., Milwaukee 46, Wis.
Henry Disston Div., H. K. Porter Co., Inc., Philadelphia 35, Pa.
Distribution Assemblies Dept., General Electric Co., 41 Woodford Ave., Plainville, Conn.
Joseph Dixon Crucible Co., Monmouth & Wayne Sts., Jersey City 3, N. J.
Dodge Div., Chrysler Corp., 7900 Jos. Campau, Detroit 31, Mich.
Dodge Mfg. Corp., South Union St., Mishawaka, Ind.
Dooley Brothers, 1201 S. Washington St., Peoria, Ill.
Dorr-Oliver, Inc., Barry Place, Stamford, Conn.
The Dow Chemical Co., Midland, Mich.
Dow Corning Corp., Midland, Mich.
Dravo Corp., Neville Island, Pittsburgh 25, Pa., ADV. p281
Drawalloy Corp., Lincoln Highway West at Alloy St., York, Pa.
Dresser Mfg. Div., Dresser Industries, Inc., Bradford, Pa.
The Ducon Co., Inc., 154 E. Second St., Mineola, N. Y.
Duff-Norton Co., 2709 Preble Ave., Pittsburgh, 30, Pa., ADV. p 269
E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.
E. I. du Pont de Nemours & Co., Inc., Explosives Div., 2543 Nemours Bldg., Wilmington 98, Del.
Duquesne Mine Supply Co., Pittsburgh 9, Pa.
Durakool, Inc., 1010 North Main St., Elkhart, Ind.
The Duriron Co., Inc., 450 North Findlay St., Dayton 1, Ohio
Dynamatic Div., Eaton Mfg. Co., 3307-14th Ave., Kenosha, Wis.

E

Eagle Iron Works, 161 Holcomb Ave., Des Moines 4, Iowa
Eaton Mfg. Co., Axle Div., 739 East 140th St., Cleveland 10, Ohio
Eavenson, Auchmuty & Greenwald, 2720 Koppers Bldg., Pittsburgh 19, Pa.
Economy Fuse & Mfg. Co., 2717 N. Greenview Ave., Chicago 14, Ill.
Thomas A. Edison Industries, McGraw-Edison Co., Storage Battery Div., Lakeside Ave., West Orange, N. J.
Eimco Corp., 630 South 4th West St., Salt Lake City, 10, Utah, ADV. p 283
Elastic Stop Nut Corp. of America, 2330 Vauxhall Rd., Union, N. J.
Electric Machinery Mfg. Co., 800 Central Ave., Minneapolis 13, Minn.
The Electric Products Co., 1725 Clarkstone Rd., Cleveland 12, Ohio
Electric Steel Foundry Co., 2141 N. W. 25th Ave., Portland 10, Oregon
Electrical Distributors Co., Penn Square Building, Philadelphia 7, Pa.
Electro-Alloys Div., American Brake Shoe Co., Taylor St. & Abbe Rd., Elyria, Ohio
Electro Dynamics Div., General Dynamics, 163 Avenue A, Bayonne, N. J.
Elliott Co., 900 N. Fourth Ave., Jeannette, Pa.
Elliott Service Co., Inc., 30 N. MacQuesten Pkwy., Mt. Vernon, N. Y.
The Elreco Corp., 2900 Cormany Ave., Cincinnati 25, Ohio
Emglo Products Div., M. Glosser & Sons Inc., 80 Messenger St., Johnstown, Pa.
Ensign-Bickford Co., Simsbury, Conn.
Ensign Electric & Mfg. Co., 914 Adams Ave., Huntington, W. Va.
Enterprise Wheel & Car Corp., Bristol, Va., ADV. p 279
Erico Products, Inc., 2070 E. 61 Pl., Cleveland 3, Ohio
Eriez Manufacturing Co., 228 Magnet Drive, Erie, Pa.
Esso Standard Oil Co., 15 West 51 St., New York, N. Y.
Eureka Casualty Co., (Fire Association Group), 401 Walnut St., Phila. 6, Pa.
Eutectic Welding Alloys Corp., 40-40 172 St., Flushing 58, N. Y.
Exide Industrial Div., Electric Storage Battery Co., 42 South 15th St., Philadelphia 2, Pa., ADV. p 267

F

The Fafnir Bearing Co., 37 Booth St., New Britain, Conn.
George E. Failing Co., Enid, Okla.
The Fairbanks Co., 393 Lafayette St., New York 3, N. Y.
Fairchild Aerial Surveys, Inc., 224 E. 11th St., Los Angeles 15, Calif.
Fairfield Engineering Co., 324 Barnhart St., Marion, Ohio
Fairmont Machinery Co., Fairmont, W. Va.
Falk Corp., 3057 W. Canal St., Milwaukee 1, Wis., ADV. p 264 A
Farrel-Birmingham Co., Inc., 25 Main St., Ansonia, Conn.
Farris Flexible Valve Corp., Palisades Park, N. J.
Farval Corp., 3249 East 80th St., Cleveland 4, Ohio
The Federal Bearings Co., Inc., Poughkeepsie, N. Y.
Femco, Inc., Irwin, Pa. ADV. p 238
Fetterman Engineering Co., 1004 Jtwn. Bank & Trust Bldg., Johnstown, Pa.
Filter Fabrics, Inc., 1279 W. Third St., Cleveland 13, Ohio
Firestone Tire & Rubber Co., Mitchell & Blizzard Aves., Akron 17, Ohio
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, Pa.
Fischer & Porter Co., 505 Warminster Rd., Hatboro, Pa.
Fisher Scientific Co., 717 Forbes St., Pittsburgh 19, Pa.
Fiske Bros. Refining Co., Lubriplate Div., 125 Lockwood St., Newark 5, N. J.
J. H. Fletcher & Co., P. O. Box 353, Huntington, W. Va.
Flexaust Co., 100 Park Ave., New York 17, N. Y.
Flexible Steel Lacing Co., 4607 Lexington St., Chicago 44, Ill.
John Flocker & Co., 644 Grant St., Pittsburgh 19, Pa.
Flood City Brass & Electric Co.,

Messenger & Elder Sts., Johnstown, Pa. ADV. p 262
Fly Ash Arrestor Corp., 280 First St. N., Birmingham, Ala.
Foote Brothers Gear & Machinery Corp., 4545 South Western Blvd., Chicago, Ill.
Ford Motor Co., P. O. Box 658, Dearborn, Mich.
L. B. Foster Co., P. O. Box 1647, Pittsburgh 30, Pa. ADV. p 16
Foster Wheeler Corp., 165 Broadway, New York, N. Y.
The Four Wheel Drive Auto Co., Clintonville, Wis.
Foxboro Co., Foxboro, Mass.
Franklin Plastics Inc., 315 Grant St., Franklin, Pa.
Frick-Gallagher Mfg. Co., 110 S. Michigan Ave., Wellston, Ohio
Fruehauf Trailer Co., 10940 Harper Ave., Detroit 32, Mich.
Fuel Process Co., 900 D St., South Charleston, W. Va. ADV. p 209
Fuller Mfg. Co., 1419 North Burdick St., Kalamazoo, Mich.
Fulton Bag & Cotton Mills, General Office, Bag Division, 1400 Annunciation St., New Orleans 13, La.
Fyr-Fyter Div., 221 Crane St., Dayton 1, Ohio

G

G & W Electric Specialty Co., 3500 W. 127th St., Blue Island, Ill.
Galigher Co., 545 West 8th South, P. O. Box 209, Salt Lake City 10, Utah
Galion Allsteel Body Co., Galion, Ohio
Galion Iron Works & Mfg. Co., Galion, Ohio
Gar Wood Industries, Inc., Wayne, Mich.
Gardner - Denver Company, Quincy, Ill.
The Garlock Packing Co., 402 East Main St., Palmyra, N.Y.
Gates Rubber Co., 999 South Broadway, Denver 17, Colo.
General Cable Corp., 420 Lexington Ave., New York 17, N. Y.
General Electric Co., Apparatus Sales Div., 1 River Road, Schenectady 5, N. Y. ADV. p 256-257
General Electric Co., Chemical and Metallurgical Div. Insulating Materials Section, 1 River Rd., Bldg. #23 Schenectady, N. Y.
General Electric Co., Communication Products Dept., Electronics Park, Syracuse, N. Y.
General Electric Co., Lamp Div., Nela Park, Cleveland, Ohio
General Electric Co., Locomotive & Car Equipment Dept., 2901 E. Lake Rd., Erie 1, Pa.
General Motors Corp., Euclid Division, 1361 Chardon Road, Cleveland, Ohio
General Nuclear Corp., 550 Fifth Ave., New York 14, N. Y.
General Scientific Equipment Co., 7516 Limekiln Pike, Philadelphia 50, Pa.
General Splice Corp., 18 Marshall St., South Norwalk, Conn.
Gensco Tools Div., General Steel Warehouse Co., Inc., 1830 N. Kostner Ave., Chicago 39, Ill.
Geo-Optic Co., Inc., 149 Church St., New York 7, N. Y.
Gering Products, Inc., North Seventh St. and Monroe Ave., Kenilworth, N. J.
Gibraltar Equipment & Mfg. Co., P. O. Box 304, Alton, Ill.
Gilson Screen Co., 110 Center St., Malinta, Ohio
Goodall Rubber Co., Whitehead Rd., Trenton, N. J.
Goodman Mfg. Co., Halsted St. & 48th Place, Chicago 9, Ill.
B. F. Goodrich Chemical Co., 3135 Euclid Ave., Cleveland 15, Ohio
B. F. Goodrich Industrial Products Co., 500 South Main St., Akron 18, Ohio
B. F. Goodrich Tire Co., A Div. of The B. F. Goodrich Co., Akron, Ohio.
Goodyear Tire & Rubber Co., 1144 East Market St., Akron 16, Ohio
Gorman-Rupp Co., Mansfield, Ohio
Gould-National Batteries, Inc., Trenton 7, N. J.
Goulds Pumps, Inc., Seneca Falls, N. Y.
Goyne Pump Co., Ashland, Pa.
Gray & Co., Inc., 60 11 Ave., N.E., Minneapolis 13, Minn.
Graybar Elec. Co., Inc., 420 Lexington Ave., New York 17, N. Y., ADV. p 282
Greene, Tweed & Co., Wales, Pa.
Greensburg Machine Co., Greensburg, Pa.
Grinnell Co., Inc., 260 West Exchange St., Providence 1, R.I.
Gruendler Crusher & Pulverizer Co., 2917 No. Market St., St. Louis 6, Mo.
Gulf Oil Corp., P. O. Box 1166, Pittsburgh 30, Pa.
T. J. Gundlach Machine Co., Div. J. M. J. Industries, Inc., 226 Centerville Ave., Belleville, Ill., ADV. p 231
Gurley, W. & L. E., 514 Fulton St., Troy, N. Y.
Gustin-Bacon Mfg. Co., 210 West Tenth St., Kansas City, Mo.
Guyan Machy. Co., 755 Stratton, Logan, W. Va.

H

Hackbridge & Hewittic Electric Co., Ltd., P. O. Box 234, Pittsburgh 30, Pa.
George Haiss Mfg. Co. Div., Pettibone Mulliken Corp., 350 Fifth Ave., New York, N. Y.
Hamilton Rubber Mfg. Corp., Meade St., Trenton, N. J.
J. V. Hammond Co., Spangler, Pa.
F. R. Hannon & Sons, 1605 Waynesburg Rd., Canton 7, Ohio
Hardinge Co., Inc., 240 Arch St., York, Pa.
Harnischfeger Corp., 4400 W. National Ave., Milwaukee 46, Wis., ADV. p 207
The Harrington & King Perforating Co., Inc., 5655 W. Fillmore St., Chicago 44, Ill.
Hartzell Propeller Fan Co., P.O. Box 909, Piqua, Ohio
Hauck Mfg. Co., 144-154 Tenth St., Brooklyn 15, N. Y.
Herb J. Hawthorne, Inc., Box 7366, Houston 8, Tex.
Hays Corp., 742 E. 8th S.T, Michigan City, Ind.
Heinemann Elec. Co., 350 Plum St., Trenton 2, N. J.
Heintz Mfg. Co., 13110 Enterprise Ave., Cleveland, Ohio
Helicoid Gage Div., American Chain & Cable Co., Inc., Bridgeport 2, Conn.
Helmick Foundry-Machine Co., P. O. Box 71, Fairmont, W. Va.
Helwig Co., 2544 N. 30th St., Milwaukee 10, Wis.
Hendrick Mfg. Co., Carbondale, Pa., ADV. p 250
Henrickson Mfg. Co., 8001 W. 47th St., Lyons, Ill.
Hendrix Mfg. Co., P. O. Box 31, Mansfield, La.
Hercules Motor Corp., 101 11 St., S.E., Canton, Ohio
Hercules Powder Co., Delaware Trust Bldg., 936 King St., Wilmington, Del., ADV. p 263
Hercules Steel Products Co., Galion, Ohio
Herold Mfg. Co., 215 Hickory St., Scranton 5, Pa.
Hevi-Duty Electric Co., 2040 W. Wisconsin Ave., Milwaukee 1, Wis.
Hewitt-Robins, Inc., 666 Glenbrook Rd., Stamford, Conn., ADV. p 258-259
Heyl & Patterson, Inc., 55 Fort Pitt Blvd., Pittsburgh 22, Pa., ADV. p 245
Hobart Bros. Co., Hobart Square, Troy 1, Ohio
Hockensmith Corp., Penn, Pa.
Hodag Chemical Corp., 7247 North Central Park, Chicago 45, Ill.
Hoffman Bros. Drilling and Mfg. Co., Tiona and Ceder Sts., Punxsutawney, Pa.
Hoffman Combustion Engrg. Co., 1780 Southfield Rd., Lincoln Park, Mich.
Robert Holmes & Bros., Inc., 510 Junction Ave., Danville, Ill.
Holub Industries, Inc., 416 DeKalb Ave., Sycamore, Ill.
Homelite, Div. of Textron Inc., 75 Riverdale Ave., Port Chester, N. Y.
Homer Mfg. Co., Inc., 142 E. Pearl St., Lima, Ohio.
Homestead Valve Mfg. Co., Coraopolis, Pa.
Hossfeld Mfg. Co., 460-462 W. Third St., Winona, Minn.
The Frank G. Hough Co., 735 Seventh St., Libertyville, Ill.
Howe Scale Co., Rutland, Vt.
Howells Mining Drill Co., Plymouth, Pa.
Hoyt Wire Cloth Co., P. O. Box 22, Lancaster, Pa., ADV. Third Cover
Huber-Warco Co., Marion, Ohio ADV. p 32
Hughes Tool Co., 300 Hughes St., Houston, Tex.
Hulburt Oil & Grease Co., Trenton & Castor Ave., Philadelphia 34, Pa.
C. B. Hunt & Son, Inc., Salem, Ohio
Hyatt Bearings Div., General Motors Corp., Harrison, N.J.
Hydramotive, Inc., 6723 Denison, Cleveland 2, Ohio.
Hyster Co., 2903-39 N.E. Clackamas St., Portland 8, Ore.
Hy-Test Safety Shoe Div., International Shoe Co., 1509 Washington Ave., St. Louis 3, Mo.

I

I-T-E Circuit Breaker Co., 19 & Hamilton Sts., Philadelphia 30, Pa.
Ideal Industries, Inc., 1020 Park Ave., Sycamore, Ill.
Ilg Electric Ventilating Co., 2850 N. Pulaski Rd., Chicago 41, Ill.
Illinois Powder Mfg. Co., 506 Olive St., St. Louis 1, Mo.
Illinois Zinc Co., 2959 W. 47th St., Chicago 32, Ill.
Imperial-Cantrell Mfg. Co., P.O. Box 538, Jellico, Tenn.
Indiana Foundry Co., Indiana, Pa.
Industrial Engrg. & Construction Co., Inc., First National Bank Bldg., Fairmont, W. Va.
Industrial Physics & Electronics Co., 470 So. 10th East Salt Lake City, Utah
Industrial Rubber Products Co., 505 Magee St., Pittsburgh 19, Pa.
Industrial Rubber Products Co., 815 Court St., Charleston, W. Va.
Industrial Sales Dept., John Bean Div., Food Machinery & Chemical Corp., Box 840, Lansing, Mich.
Ingersoll-Rand Co., 11 Broadway, New York 4, N. Y., ADV. p 6-7
Inland Steel Co., 38 S. Dearborn St., Chicago 3, Ill.
Insley Mfg. Corp., 801 Olney St., Indianapolis 6, Ind.
Instrument Div., Gichner, Inc., 1900 Kendall St., N.E., Washington 2, D. C.
Insul-Mastic Corp. of America, 7750 West 61 Place, Summit, Ill.
International Harvester Co., Construction Equipment Div., North Ave. and Manheim Rd., Melrose Park, Ill.
International Harvester Co., Motor Truck Div., 180 N. Michigan Ave., Chicago 1, Ill.
International Nickel Co., Inc., 67 Wall St., New York 5, N. Y.
International Salt Co., Inc., Scranton 2, Pa.
Interstate Equipment Div., Yara Engineering Corp., 18 West Jersey St., Elizabeth 4, N. J.
Iowa Mfg. Co., 916 16 St., N.E., Cedar Rapids, Iowa
Ironton Engine Co., Farmingdale, N. J.
Irwin Foundry & Mine Car Co., Box 311, Irwin, Pa.
Irvington Div., Minnesota Mining & Mfg. Co., 6 Argyle

Terrace, Irvington 11, N. J.

J

Jeffrey Mfg. Co., 922 N. Fourth St., Columbus 16, Ohio
Jenkins Bros., 100 Park Ave., New York 17, N. Y.
Jesco Lubricants Co., P. O. Box 7331, Kansas City 16, Mo.
Jet-Lube, Inc., 3093 N. California St., Burbank, California
Johns-Manville, 22 East 40 St., New York 16, N. Y. ADV. p 244
Johnson Bronze Co., 492 S. Mill St., New Castle, Pa.
Johnson-March Corp., 1724 Chestnut St., Philadelphia 3, Pa.
Johnson Plastics Corp., P. O. Box 268, Chagrin Falls, Ohio
R. G. Johnson Co., Washington Trust Bldg., Washington, Pa.
Johnston Pump Co., Div. of The Youngstown Sheet and Tube Co., P. O. Bin K, Pasadena, Calif.
Jones & Laughlin Steel Corp., 3 Gateway Center, Pittsburgh 30, Pa., ADV. pp 15, 217
Joy Mfg. Co., 333 Oliver Bldg., Pittsburgh 22, Pa., ADV., Insert, pp 208-209
Coal Machy. Div., 4107 Sennott St., Pittsburgh 13, Pa.; 742 Eighth Ave., P. O. Box 1208, Huntington 14, W. Va.; Box 1152, Kingston, Pa.; 1203 Macklind Ave., St. Louis 10, Mo.; 1626 Wazee St., Denver 2, Colo.
Joyce Cridland Co., 2027 East First St., Dayton 3, Ohio
Judsen Rubber Works, Inc., 4107 West Kinzie St., Chicago 24, Ill.

K

Kaiser Aluminum & Chemical Sales, Inc., 919 N. Michigan Ave., Chicago, Ill.
Kanawha Mfg. Co., Charleston 26, W. Va.
Keasbey & Mattison Co., Ambler, Pa.
Keenan Oil Co., Parkway Dr., Cincinnati, Ohio
Kelly Mfg. Co., 503-505 Broad St. Charleston 21, W. Va.
Kennametal, Inc., Mining Tool Div. Bedford, Pa. ADV., Insert, pp 232-233
Kennedy Valve Mfg. Co., Elmira, N. Y.
Kennedy-Van Saun Mfg. & Engrg. Corp., 2 Park Ave., New York, N. Y.
Kensington Steel, Div. of Poor & Co., 505 Kensington Ave., Chicago 28, Ill.
The Kerite Co., 30 Church St., New York 7, N. Y.
Kern Instruments, Inc., 120 Grand St., White Plains, N.Y.
Kersey Manufacturing Co., Inc., P. O. Box 151, Bluefield, Va.
Keuffel & Esser Co., Adams & Third Sts., Hoboken, N. J.
Keystone Carbon Co., 1933 State St., St. Marys, Pa.
Keystone Lubricating Co., 21 & Clearfield Sts., Philadelphia 32, Pa.
Walter Kidde & Co., Inc., 357 Main St., Belleville 9, N. J.
King Powder Co., Inc., 1703 First National Bank Bldg., Cincinnati 1, Ohio L
S. P. Kinney Engineers, Inc., 201 Second Ave., Carnegie, Pa.
Kirk & Cowin, 1 18th St. SW, Birmingham, Ala.
Kling Bros. Engineering Works 1320 N. Kostner Chicago 51, Ill.
Koehring Co., 31 & Concordia Ave., Milwaukee 16, Wis.
Koppers Co., Inc., Metal Products Div., 200 Scott St., Baltimore 3, Md.
Koppers Co., Inc., Wood Preserving Div., 1477 Koppers Bldg., Pittsburgh 19, Pa., ADV. p 280
L. O. Koven & Bro., Inc., 154 Ogden Ave., Jersey City 7, N. J.
Kremser & Sons, Inc., Frank A., P. O. Box 6207 Holmesburg Station, Philadelphia 36, Pa.
Kuhlman Elec. Co., 26 & Jefferson Sts., Bay City, Mich.

L

Laboratory Equipment Corp., St. Joseph, Mich.
LaBour Co., Inc., 1607 Sterling Ave., Elkhart, Ind.
Laclede Stoker Co., 4438 Hunt Ave., St. Louis 10, Mo.
Ladish Co., 5481 S. Packard Ave., Cudahy, Wis.
Lancaster Pump & Mfg. Co., Lancaster, Pa.
Laubenstein Mfg. Co., Ashland, Pa.
Layne & Bowler, Inc., Box 6697, Hollywood Sta., Memphis 8, Tenn.
Lecco Machinery & Engineering Co., P. O. Box 3036, Bluefield, W. Va.
Leeden Mfg. Co., 1600 San Pedro St., Los Angeles, Calif.
Lee-Norse Co., Lincoln Avenue Extension Charleroi, Pa.
Leetonia Tool Co., 142 Main St., Leetonia, Ohio
LE-HI div., Hose Accessories Co., 17th St. & Lehigh Ave., Philadelphia 32, Pa.
Leland Electric Co., Div. American Machine & Foundry Co., 1501 Webster St., Dayton 1, Ohio
Leman Machine Co., S. Railroad St., Portage, Pa. ADV. p 264
Le Roi Div., Westinghouse Air Brake Co., Milwaukee 1, Wis., ADV. p 275
Leschen Wire Rope Div., H. K. Porter Co., Inc., 2727 Hamilton Ave., St. Louis 12, Mo.
LeTourneau-Westinghouse Co., 2301 N.E. Adams St., Peoria, Ill.
Linatex Corp. of America, Rockville, Conn. ADV. p 249
Lincoln Electric Co., 22801 St. Clair, Cleveland 17, Ohio
Lincoln Engrg. Co., 5701 Natural Bridge Ave., St. Louis 20, Mo., ADV. p 14
Link-Belt Co., Dept. CAMGL-57, Prudential Plaza, Chicago 1, Ill. ADV. p 213
Link-Belt Speeder Corp., Cedar Rapids, Iowa
Lippmann Engrg. Works, Inc., 4603 West Mitchell St., Milwaukee, Wis.
Herbert S. Littlewood, R. D. 3, Irwin, Pa.
Peter F. Loftus Corp., First National Bank Bldg., Pittsburgh 22, Pa.
The Long Co., P. O. Box 331, Oak Hill, W. Va. ADV. pp 220-221
E. J. Longyear Co., 1701 Foshay Tower, Minneapolis, Minn.
Ludlow Saylor Wire Cloth Co., 634 South Newstead, St. Louis, 10, Mo., ADV. p 216
Ludlow Valve Mfg. Co., Inc., P. O. Box 388, Troy 1, N. Y.
Lufkin Rule Co., 1730 Hess Ave., Saginaw, Mich.
Lunkenheimer Co., Beekman St. and Waverly Ave., Cincinnati 14, Ohio

M

Mack Trucks, Inc., 1355 West St., Plainfield, N. J. ADV. p 277
Macwhyte Co., 2931 14th Ave., Kenosha, Wis.
Magic Chemical Co., 121 Crescent St., Brockton 2, Mass.
Magnetic Engrg. & Mfg. Co., 851 Van Houten Ave., Clifton, N. J. L
The R. C. Mahon Co., 6566 East Eight Mile Rd., Detroit 34, Mich.
Majac, Inc., Sub. of Blackstone Corp., 23 St. & P.R.R., Sharpsburg, Pittsburgh 15, Pa.
Mall Tool Co., Div. of Remington Arms Co., Inc., 25000 So. Western Ave., Park Forest, Ill.
Manheim Mfg. & Belting Co., 470 Stiegel St., Manheim, Pa.
Manitowoc Engineering Corp., 16th St., Manitowoc, Wis., ADV. p. 226
Manning, Maxwell & Moore, Inc., Shaw-Box Crane & Hoist Div., Muskegon, Mich.
Manu-Mine Research & Development Co., P. O. Box 167, Reading, Pa.
Manzel Div., Houdaille Industries, Inc., 315 Babcock St., Buffalo 10, N. Y.
Marathon Coal Bit Co., Inc., Box 391, Montgomery, W. Va.
Marietta Concrete Corp., Box 356, Marietta, Ohio
Marietta Mfg. Co., Point Pleasant, W. Va.
Marion Handle Mills, Inc., Marion, Va.
Marion Metal Products Co., Chaney Ave., Marion, Ohio
Marion Power Shovel Co., Marion, Ohio
Marland One-Way Clutch Co., 561 Hillgrove Ave., La Grange, Ill.
Marlin-Rockewell Corp., 402 Chandler St., Jamestown, N. Y.
Marlow Pumps, Div. of Bell & Gossett Co., Box 200, Midland Park, N. J.
Marmon-Herrington Co., Inc., 1511 W. Washington St., Indianapolis 7, Ind.
E. F. Marsh Engrg. Co., 4324 W. Clayton Ave., St. Louis 10, Mo.
Martin Engrg. Co., U.S. Route #34, Neponset, Ill.
Martindale Electric Co., 1307 Hird Ave., Cleveland 7, Ohio ADV. p. 285
Master Bronze Powder Co., Inc., 538-548 W. State St., Calumet City, Ill.
Master Electric Co., 126 Davis Ave., Dayton 1, Ohio
Mayo Tunnel & Mine Equipment Co., Lancaster, Pa.
McGill Mfg. Co., Inc., Valparaiso, Ind.
McLanahan & Stone Corp., Hollidaysburg, Pa., ADV. p 211
McLaughlin Mfg. Co., Inc., 801 E. Cass St., Joliet, Ill.
McNally-Pittsburg Mfg. Corp., 307 West Third St., Pittsburg, Kan., ADV., Insert pp 200-201
Meckum Engr. Co., 53 W. Jackson Blvd., Chicago 4, Ill.
John F. Meissner Engineers, Inc., 300 W. Washington St., Chicago 6, Ill.
Merrick Scale Mfg. Co., 184 Autumn St., Passaic, N. J., ADV. p 244
Metal Carbides Corp., 6001 Southern Blvd., Youngstown 12, Ohio
Metal & Thermit Corp., Rahway, N. J.
Metallurgical Products Dept., General Electric Co., Box 237, Roosevelt Park Annex, Detroit 32, Mich.
Mexico Refractories Co., Mexico, Mo.
Mica Insulator Co., 797 Broadway, Schenectady, N. Y.
Midland Pipe & Supply Co., 2829 S. 61st St., Chicago, Ill.
Mine Safety Appliances Co. .201 North Braddock Ave., Pittsburgh 8, Pa., ADV. pp 12-13
Miners' Hardware Supply Co., 525½ Brushton Ave., Pittsburgh 21, Pa., ADV. p 270
Mining Machine Parts Inc., 2701 St. Clair Ave., Cleveland 14, Ohio
Mining Progress, Inc., P. O. Box 3, Highland Mills, N. Y.
Minneapolis-Honeywell Regulator Co., Industrial Division, Wayne and Windrim Aves., Phila. 44, Pa.
Minneapolis-Moline Co., Box 1050, Minneapolis 1, Minn.
Mitchell Industrial Tire, Inc., Box 468, Chattanooga, Tenn.
Mobile Aerial Towers, Inc., 1730 N. Harrison St., Fort Wayne, Ind.
Mobile Drilling Inc., 960 North Pennsylvania, Indianapolis 4, Ind.
Moloney Electric Co., 5390 Bircher Blvd., St. Louis 20, Mo.
Monsanto Chemical Co., Organic Chemicals Div., 800 N. 12 Blvd., St. Louis 1, Mo.
The Moore Co., 1036 Quarrier St., Charleston, W. Va.
Morris Machine Works, Baldwinsville, N. Y., ADV. p 2

Morse Bros. Machinery Co., 2900 Brighton Blvd., Denver 1, Colo.
Morse Chain Co., A Borg-Warner Industry, Ithaca, N.Y.
Morton Salt Co., 120 S. LaSalle St., Chicago 3, Ill.
Mosebach Electric & Supply Co., 115 Arlington Ave., Pittsburgh 3, Pa.
T. J. Moss Tie Co., 700 Security Bldg., St. Louis 2, Mo.
Motorola Communications & Electronics, Inc., 4501 West Augusta Blvd., Chicago 51, Ill.
Mott Core Drilling Co., 830 Eighth Ave., Huntington 17, W. Va.
Mountain State Equipment Co. P. O. Box 1050 Beckley, W. Va.
Mount Sopris Instrument Corp., 1320 Pearl St., Boulder, Colo.
Murphy Diesel Co., 5317 West Burnham St., Milwaukee, Wis.
Myers-Whaley Co., P. O. Box 789, Knoxville 1, Tenn. ADV. p 266

N

Nachod & U. S. Signal Co., 4777 Louisville Ave., Louisville 9, Ky., ADV. p 240
Nagle Pumps, Inc., 1237 Center Ave., Chicago Heights, Ill.
Nash Engineering Co., South Norwalk, Conn.
Nathan Mfg. Corp., 45-02 Ditmars Blvd., Long Island City 5, N. Y.
National Carbon Co., Division of Union Carbide Corp., 30 East 42nd St., New York 17, N. Y.
National Electric Coil Co., 800 King Ave., Columbus 16, Ohio
National Electric Products Co., Gateway Center, Bldg. 2, 140 Stanwix St., Pittsburgh 22, Pa.
National Filter Media Corp., 1717 Dixwell Ave., New Haven 11, Conn.
National Malleable & Steel Castings Co., 10600 Quincy Ave., Cleveland 6, Ohio, ADV. Second Cover
National Mine Service Co., 1260 Maple St., Indiana, Pa.; Clarkson Div., Nashville, Ill., Bemeco Div., Beckley W. Va.; All-State Div., Logan. W. Va.; Kentucky-Virginia Div., Jenkins, Ky.; Whiteman Div., Indiana, Pa. and Morgantown, W. Va.; Ashland Div., Ashland, Ky.; Anthracite Div., Forty Fort, Pa.; Western Kentucky Div., Madisonville, Ky.
National Powder Co., Eldred, Pa.
National Supply Company, #2 Gateway Center, Pittsburgh, Pa.
National Tube Div., United States Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa.
Naylor Pipe Co., 1262 E. 92 St., Chicago 19, Ill.
Neff & Fry Co., Camden, Ohio
Newcomer Products, Inc., Latrobe, Pa.
New Departure Div., General Motors Corp., Bristol, Conn.
New Jersey Meter Co., Plainfield, N. J.
New York Air Brake Co., Aurora Div., New York Air Brake Co., 619 Loucks Ave., Aurora, Ill.; Kalamazoo Div., New York Air Brake Co., 9000 E. Michigan Ave., Kalamazoo, Mich.; Kinney Mfg. Div., New York Air Brake Co., 3529 Washington St., Boston 30, Mass.
New York Belting & Packing Co., 1 Market St., Passaic, N. J.
New York & New Jersey Lubricant Co., 292 Madison Ave., New York 17, N. Y.
Newark Wire Cloth Co., 351 Verona Ave., Newark 4, N. J.
R. W. Nichols Co., 101 Investment Bldg., Pittsburgh 22, Pa.
The Nolan Co., Bowerston, Ohio, ADV. p 229
Nordberg Mfg. Co., 3073 South Chase Ave., Milwaukee 1, Wis., ADV., Fourth Cover
Norma-Hoffman Bearing Corp., Stamford, Conn.
Northwest Engineering Co., 135 S. La Salle St., Chicago 3, Ill.
Norton Co., 1 New Bond St., Worcester 6, Mass.
B. J. Nykerk Corp., 42 Broadway, New York 4, N. Y.

O

Ohio Brass Co., Mansfield, Ohio
Ohio Carbon Co., 12508 Berea Road, Cleveland 11, Ohio
Ohio Oil Co., Findlay, Ohio
Okonite Co., Canal St., Passaic, N. J.
Olin-Mathieson Chemical Corp., Explosives Div., 600 Grant St., Pittsburgh 19, Pa.
Oliver Corp., 400 West Madison St., Chicago 6, Ill.
Oliver Iron & Steel Corp., South 10th & Muriel St., Pittsburgh 3, Pa.
Onox, Inc., 121 Second St., San Francisco, 5, Calif.
Orange Roller Bearing Co., Inc., 557 Main St., Orange, N. J.
The Ore & Chemical Corp., 80 Broad St., New York, N. Y.
Ore Reclamation Co., 301 No. Connell Ave., Pichner, Okla.
Orefraction, Inc., 7425 Thomas St., Pittsburgh 8, Pa.
Orton Crane & Shovel Co., 608 S. Dearborn St., Chicago 5, Ill.
Oshkosh Motor Truck, Inc., Oshkosh, Wis.
Osmose Wood Preserving Co., 980 Ellicott St., Buffalo 9, N. Y.
The Oster Mfg. Co., 1340 E. 289th St., Wickliffe (Cleveland), Ohio

P

Page Engineering Co., Clearing Post Office, Chicago 38, Ill.
Page Steel & Wire Div., American Chain & Cable Co., Inc., Monessen, Pa.
Palnut Co., Sub. United-Carr Fastener Corp., Gelen Road, Mountainside, N. J.
Pangborn Corp., 670 Pangborn Blvd., Hagerstown, Md.
Paris Mfg. Co., Paris, Ill. ADV. p 278
Pattin Mfg. Co., Marietta, Ohio
Peerless Photo Products, Inc., Shoreham, N. Y.
Peerless Pump Div., Food Machinery & Chemical Corp., 301 West Ave. 26, Los Angeles 31, Calif.
Penn Machine Co., 106 Station St., Johnstown, Pa.
Pennsylvania Crusher Div., Bath Iron Works Corp., Room 1711 West Chester, Pa.
Pennsylvania Drilling Co., 1201 Chartiers Ave., Pittsburgh 20, Pa.; Masonry Drill Div., 1201 Banksville Rd., Pittsburgh 16, Pa.
Pennsylvania Electric Coil Corp., 1301 Saw Mill Run Blvd., Pittsburgh 26, Pa.
Pennsylvania Pump & Compressor Co., Easton, Pa.
Pennsylvania Refining Co., Butler, Pa.
Perfection Steel Body Co., Galion, Ohio
The Permutit Co., 50 West 44th St., New York 36, N. Y.
Peterson Filters & Engineering Co., 137 Social Hall Ave., Salt Lake City, Utah
J. B. Pfister Co., 662 Ohio St., Terre Haute, Ind.
Phelps Dodge Copper Products Co., 300 Park Ave., New York 22, N. Y.
Philadelphia Gear Works, Erie Ave. & G Sts., Philadelphia 34, Pa.
Phoenix Iron & Steel Co., Structural & Tube Divisions, Phoenixville, Pa.; Plate Div., Harrisburg, Pa.; Phoenix Bridge Co., Phoenixville, Pa.
Phoenix Metal Products, Metal Spinning Div., 4715 North 27 St., Milwaukee, Wis.
Pierce Management, Inc., Scranton Electric Bldg., Scranton 3, Pa.
Pioneer Engineering, Div. of Poor & Co., 3200 Como Ave., Minneapolis 14, Minn.
Pitman Manufacturing Co., 300 West 79th Terrace, Kansas City 14, Mo.
Pittsburgh Corning Corp., 1 Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Gear Co., Neville Island, Pittsburgh 25, Pa.
Pittsburgh Plate Glass Co., One Gateway Center, Pittsburgh 22, Pa.
Pittsburgh Screw & Bolt Corp., P. O. Box 1708, Pittsburgh 30, Pa.
The Plastex Co., 3232 Cleveland Ave., Columbus 24, Ohio
Plymouth Locomotive Works, Div. of the Fate-Root-Heath Co., Plymouth, Ohio
Plymouth Rubber Co., Inc., 51 Revere St., Canton, Mass.
H. K. Porter, Inc., 74 Foley St., Somerville, Mass.
Porto Pump, Inc., 19735 Ralston, Detroit 3, Mich.
The Post Glover Electric Co., P. O. Box 709 Covington, Ky.
Prime Mover Co., Muscatine, Iowa
K. Prins & Associates, Wellston Ohio
Productive Equipment Corp., 2926 West Lake St., Chicago 12, Ill.
Proto Tool Co., Div. of Pendleton Tool Industries, Inc., 2209 Santa Fe Ave., Los Angeles, Calif. ADV. p 264
Frank Prox Company, Inc., 1201 South 1st St., Terre Haute, Ind.
Pulmosan Safety Equip. Co., 644 Pacific St., Brooklyn, N. Y.
Pure Carbon Co., Inc., 441 Hall Ave., St. Marys, Pa.
Pure Oil Co., 35 East Wacker Dr., Chicago 1, Ill.

Q

Quaker Rubber Div., H. K. Porter Co., Tacony & Comly Streets, Phila. 24, Pa.
Quick-Way Truck Shovel Co., 2401 E. 40th Ave., Denver, Colo.

R

R-P & C Valve Div., American Chain & Cable Co., Inc., Reading, Pa.
Radiant Lamp Corp., 300 Jelliff Ave., Newark 8, N. J.
Raybestos Manhattan, Inc., Manhattan Rubber Div., 42 Townsend St., Passaic, N. J.
Read, Davis, 120 S. La Salle St., Chicago, Ill.
Ready Power Co., 11231 Freud Ave., Detroit, Mich.
Red Jacket Co., Inc., 500 Bell Ave., Carnegie, Pa.
Reeves Pulley Co. Div. of Reliance Electric & Engineering Co., 1225 7th St., Columbus, Ind.
Reich Bros. Mfg. Co., Inc., 1439 Ash St., Terre Haute, Ind., ADV. p 237
Reid Belt & Rubber Co. Inc., 917 Grant St., Bluefield, W. Va.
George P. Reintjes Co., 2517-19 Jefferson St., Kansas City 6, Mo.
Reliance Elec. & Eng. Co., 24701 Euclid Ave., Cleveland 17, Ohio
Remaly Mfg. Co., Tamaqua, Pa.
Remington Arms Co., Inc., 939 Barnum Ave., Bridgeport 2, Conn.
Reo Motors, Inc., 1331 South Washington St., Lansing 20, Mich.
Republic Creosoting Co., 1615 Merchants Bank Bldg., Indianapolis 4, Ind.
Republic Rubber Div., Lee Rubber & Tire Co., Youngstown 1, Ohio
Republic Steel, Republic Bldg., Cleveland 1, Ohio
Resisto-Loy Co., Inc., 1251

Phillips Ave., S.W., Grand Rapids 7, Mich.
Revere Copper & Brass, Inc., 230 Park Ave., New York 17, N. Y.
Reynolds Metals Co., 2500 South Third St., Louisville 1, Ky.
Rice Pump & Machine Co., Belgium, Wis.
Riegel Textile Corp., 260 Madison Ave., New York, N. Y.
Robbins & Meyers, Inc., 1345 Lagonda Ave., Springfield, Ohio
Roberts & Schaefer Co., Sub. Thompson-Starrett Co., Inc., 130 N. Wells St., Chicago 6, Ill., ADV. p 208
Robinson & Robinson, Union Bldg., Charleston, West Va.
Robinson Ventilating Co., Zelienople, Pa.
Rochester Ropes Inc., Culpeper, Va.
Rockbestos Products Corp., Nicoll and Canner Sts., New Haven 4, Conn.
Rockwell Mfg. Co., 400 N. Lexington Ave., Pittsburgh 8, Pa.
John A. Roebling's Sons Corp., Sub. Colorado Fuel & Iron Corp., 640 South Broad St., Trenton 2, N. J.
Rollway Bearing Co., Inc., 541 Seymour St., Syracuse 4, N.Y.
Rome Cable Corp., 330 Ridge St., Rome, N. Y., ADV. p 8
Roots-Connersville Blower Div., Dresser Industries, Inc., 900 W. Mount St., Connersville, Ind.
Ross Screen & Feeder Co., 100 Quimby St., Westfield, N. J.
The Ruberoid Co., 500 Fifth Ave., New York 36, N. Y., ADV. p 276
Ruger Equipment, Inc., 615 W. 4th St., Uhrichsville, Ohio
Rust-Oleum Corp., 2425 Oakton St., Evanston, Ill.
Rydin Railway Equip. Co., Railway Exch. Bldg., Chicago 4, Ill.
Joseph T. Ryerson & Son, Inc., 16 & Rockwell Sts., P. O. Box 8000A, Chicago 80, Ill.

S

SKF Industries, Inc., P. O. Box 6731, Philadelphia 32, Pa.
Saginaw Bearing Co., 821 South Water St., Saginaw, Mich.
St. Louis Screw & Bolt Co., 6900 North Broadway, St. Louis 15, Mo.
Salem-Brosius, Inc., P. O. Box 2222, Pittsburg 30, Pa.,
The Salem Tool Co., 767 S. Ellsworth Ave., Salem, Ohio, ADV. p 211
Sanford Day Iron Works, Inc., P. O. Box 1511, Knoxville 9, Tenn.
Sauerman Bros., Inc., 620 South 28th Ave., Bellwood, Ill.
W. J Savage Co., 912 Clinch Ave., Knoxville 2, Tenn.
Scandinavia Belting Co., P. O. Box 464, Newark 1, N. J.
Schaffer Poidometer Co., 2828 Smallman St., Pittsburgh 22, Pa.
Schield Bantam Co., 221 Park St., Waverly, Iowa
Schramm, Inc., 870 E. Virginia Ave., West Chester, Pa. ADV p 1
Schroeder Bros. Corp., Nichol Ave., Box 72, McKees Rocks, Pa.
Scranton Electric Construction Co., 625 Connell Bldg., Scranton, Pa.
Screen Equipment Co. Inc., Buffalo 25, N. Y.
Seiberling Rubber Co., Akron 9, Ohio
Sheffield Div., Armco Steel Corp., Sheffield Sta., Kansas City, Mo.
Shell Oil Co., 50 W. 50th St., New York, N. Y.
Shepard Niles Crane & Hoist Corp., Schuyler Ave., Monour Falls, N. Y.
R. H. Shepard Co., Inc., Hantour Falls, N. Y.
The Sight Feed Generator Co., 38 E. Third St., West Alexandria, Ohio
Sika Chemical Corp., 33-47 Gregory Ave., Passaic, N. J.
Silver Engineering Works, Inc., 3309 Blake St., Denver 5, Colo.
Simonds Saw & Steel Co., 470 Main St., Fitchburg, Mass.
Simplex Wire & Cable Co., 79 Sidney St., Cambridge 39, Mass.
Simplicity Engineering Co., Durand, Mich.
Slip-On, Inc., 401 Broadway, New York, N. Y.
J. K. Smit & Sons, Inc., Murray Hill, N. J.
A. O. Smith Corp., 3533 N. 27th St., Milwaukee 1, Wis.
Smith Engineering Works, 502 East Capitol Dr., Milwaukee, Wis.
Snap-On Tools Corp., 8132 28 Ave., Kenosha, Wis.
The Snow-Nabstedt Gear Corp., 251 Welton St., Hamden 7, Conn.
Solvay Process Div., Allied Chemical & Dye Corp., 61 Broadway, New York 6, N. Y.
South Bend Lathe Works, 425 E. Madison St. South Bend 22, Ind.
Spang & Company, P. O. Box 751, Butler, Pa.
Speer Carbon Co., St. Marys, Pa.
Spencer Chemical Co., Dwight Bldg., Kansas City, Mo., ADV. p 228
Sprague & Henwood, 221 West Olive St., Scranton, Pa.
W. F. Sprengnether Instrument Co., Inc., 4576 Swan Ave., St. Louis 10, Mo.
Sprout, Waldron & Co. Inc., 94 Logan St., Muncy, Pa.
Square D Co., 6060 Rivard St., Detroit 11, Mich.
Stackpole Carbon Co., St. Marys, Pa.
The W. R. Stamler Corp., Paris, Ky., ADV. p 268
Standard Carbon Co., P. O. 49, Steubenville, Ohio
Standard Devices Co., 3231 Warrensville Center, Cleveland 22, Ohio. ADV. p 218
Standard Oil Co. (Ind.), 910 South Michigan Ave., Chicago 80, Ill.
Star Jack Co., Inc., 420 Lexington Ave., New York 17, N. Y.
Star-Kimble Motor Div., Miehle Printing Press & Mfg. Co., 200 Bloomfield Ave., Bloomfield, N. J.
Stardrill-Keystone Co., 920-17th St., Beaver Falls, Pa.
Stearns Magnetic Products, 635 So. 28th St., Milwaukee 46, Wis.
The Stearns-Roger Mfg. Co., 660 Bannock St., P. O. Box 5370, Denver 17, Colo.
Stedman Foundry & Machine Co., Inc., Aurora, Ind.
Steel-Bilt Construction Co., P. O. Box 309, Bridgeville, Pa.
Steelcote Mfg. Co., 3418 Gratiot St., St. Louis, Mo.
Steelcraft Mfg. Co., 9017 Blue Ash Rd., Cincinnati 42, Ohio
Stephens-Adamson Mfg. Co., 2 Ridgeway Ave., Aurora, Ill.
Sterling Steel Casting Co., P. O. Box 230, East St. Louis, Ill.
Stewart-Warner Corp., Alemite Div., 1826 Diversey Pkwy., Chicago 14, Ill.
Stonhard Co., Inc., 1306 Spring Garden St., Philadelphia 23, Pa., ADV. p 284
Stoody Co., 11943 East Slauson Ave., Whittier, Calif.
Stop Fire, Inc., U. S. Highway No. 1 Blackhorse Lane, New Brunswick, N. J.
Straub Mfg. Co., Inc., 8383 Baldwin St., Oakland 21, Calif.
Stulz-Sickles Co., 929-939 Port Ave. at Julia St., Elizabeth, N. J.
Sturtevant Mill Co., 103 Clayton St., Dorchester, Boston 22, Mass.
Sun Oil Co., 1608 Walnut St., Philadelphia 3, Pa.
Superior Carbon Products, Inc., 9115 George Ave., Cleveland 5, Ohio.
Peter O. Sutphen, P. O. Box 58, Everett, Pa., ADV. p 212
Suverkrop Instruments, P. O. Box 436, Bakersfield, Calif.
Swan-Finch Petrochemicals 5849 W. 66th St., Chicago, Ill.
Syntron Co., 975 Lexington Ave., Homer City, Pa.

T

Talcott, Inc., 91 Sabin St., Providence 1, R. I.
Talk-A-Phone 1514 S. Pulaski Rd., Chicago 23, Ill.
Taller & Cooper, 75 Front St., Brooklyn, N. Y.
Tamping Bag Co. Div., Pickard Industries, Inc., Mt. Vernon, Ill.; Central Mine Supply Co. Div., Pickard Industries, Inc., Mt. Vernon, Ill.
Taylor-Wharton Co. Div., Harsco Corp., High Bridge, N. J.
Templeton, Kenly & Co., 16th & Gardner Rd., Broadview, Ill., ADV. p 272
Templeton-Matthews Corp., 905 Sycamore Bldg., Terre Haute, Ind.
The Texas Co., 135 East 42nd St., New York 17, N. Y., ADV. pp 4-5
Thermoid Co., Trenton, N. J.
Thew Shovel Co., Lorain, Ohio
Thomas Engineering & Construction Co., Box 646, Greensburg, Pa.
Thomas Flexible Coupling Co., Main Ave. and Biddle St., Warren, Pa.
Thor Power Tool Co., 175 North State St., Aurora, Ill.
Thurman Scale Co., Div. Thurman Mfg. Co., 156 North Fifth St., Columbus, Ohio
Tidewater Oil Co., 17 Battery Pl., New York 4, N. Y.
Timken Detroit Axle Div., Rockwell Spring & Axle Co., 100-400 Clark St., Detroit 32, Mich.
The Timken Roller Bearing Co., 1835 Dueber Ave., S.W., Canton 6, Ohio
Toledo Pipe Threading Machine Co., 1445 Summit Ave., Toledo 4, Ohio
The Tool Steel Gear & Pinion Co., 211 Township Ave., Cincinnati 16, Ohio
H & L Tooth Co., 1540 South Greenwood Ave., Montebello, Calif., ADV. p 235
Torrington Co., 59 Field St., Torrington, Conn.
Trabon Engineering Corp., 28815 Aurora Rd., Solon, Ohio
Tractomotive Corp., Box 632, County Line Rd., Deerfield, Ill.
Bertrand P. Tracy Co., 919 Fulton St., Pittsburgh 12, Pa., ADV. p 201
Transall, Incorporated, P. O. Box 1588, 109 North 11 St., Birmingham 4, Ala.
Traylor Engineering & Mfg. Co., Allentown, Pa.
Triangle Conduit & Cable Co., Inc., Box 711, Triangle & Jersey Aves., New Brunswick, N. J.
Tri-County Building Service, P. O. Box 405, Taylorville, Ill.
Trico Fuse Mfg. Co., 2948 N. 5th St., Milwaukee 12 Wis.
Trombetta Solenoid Corp., 329 N. Milwaukee Street, Milwaukee 2, Wis.
Truck Engineering Co., 1285 W. 70th St., Cleveland 2, Ohio
Tube Turns, Div., National Cylinder Gas Co., 224 E. Broadway, Louisville 1, Ky.
Tweco Products, Inc., 1450 South Mosley, Wichita 1, Kan.
Twin Disc Clutch Co., Racine, Wisc.; Hydraulic Div. and Export Div., Rockford, Ill.
W. S. Tyler Co., 3615 Superior Ave., Cleveland 14, Ohio
Tyson Bearing Corp., Sub. of SKF Industries, Inc., Massillon, Ohio

U

Union Switch & Signal Div. of Westinghouse Air Brake Co., Pittsburgh 18, Pa.
Union Wire Rope Corp., 2100 Manchester Ave., Kansas City 26, Mo.
Unit Crane & Shovel Corp., 6411 West Burnham St., Milwaukee 19, Wisc.
U. S. Electrical Motors, Inc., 200 East Slauson Ave., Los

Angeles 54, Calif.
United States Pipe & Foundry Co., 3300 First Ave., Birmingham 2, Ala.
United States Rubber Co., 1230 Ave. of the Americas, New York 20, N. Y.
U. S. Safety Service Co., 1331 Oak St., Kansas City 6, Mo.
U. S. Steel Corp., 525 William Penn Place, Pittsburgh 30, Pa. ADV. pp 222-223
Universal Engineering Co., 625 C Ave., Northwest, Cedar Rapids, Iowa
Universal Road Machinery Co., Kingston, N. Y.
Universal Vibrating Screen Co., Deane Blvd. & St. Paul R. R., Racine, Wisc.
Upson-Walton Co ,.12515 Elmwood Ave., Cleveland 11, Ohio
Utility Mine Equipment Co., 1010 Collingwood Rd., St. Louis 24, Mo.

V

Valvoline Oil Co., Div. Ashland Oil & Refining Co., 639 Third Ave., Freedom, Penna.
R. T. Vanderbilt Co., Inc., 230 Park Ave., New York, N. Y. ADV. p 274
Varel Mfg. Co., Inc., 9230 Denton Dr., Dallas, Texas
Vascoloy-Ramet Corp., 800 Market St., Waukegan, Ill.
Vibration Measurement Engineers, Inc., 725 Oakton Ave., Evanston, Ill.
Vickers Inc., Administrative & Engineering Center Detroit, 32, Mich.
Vickers, Inc., Tulsa Winch Div., 815 East First St., Tulsa 20, Okla.
Victaulic Co. of America, Box 509, Elizabeth, N. J., ADV. p 210
Victor Equipment Co., 844 Folsom St., San Francisco 7, Calif.
Viking Machinery Sales Corp., 205 O'Brien Rd., Jackson, Mich.
Visking Co., Plastics Div., P. O. Box 1410, Terre Haute, Ind.
Vulcan Iron Works, 730 South Main St., Wilkes Barre, Pa.

W

Wagner Electric Corp., 6400 Plymouth Ave., St. Louis 14, Mo.
Wall Colmonoy Corp., 19345 John R. St., Detroit 3, Mich.
Walter Motor Truck Co., 1001-19 Irving Ave., Ridgewood, L. I., N. Y.
Walworth Co., 60 East 42nd St., New York 17, N. Y.
Warner Laboratories, Creston, Pa. ADV. p 270
Warren Refining & Chemical Co., 5151 Denison Ave., Cleveland 2, Ohio
Watt Car & Wheel Co., Barnesville, Ohio
Waukesha Motor Co., West St. Paul Ave., Waukesha, Wis.
Weatherhead Co., Fort Wayne Div., 128 W. Washington St., Fort Wayne, Ind.
The Webb Corp., Box 549, Webb City, Mo.
Webster Mfg., Inc., Tiffin, Ohio
Wedge Wire Corp., Gas St. & N. P. R. R., Wellington, Ohio, ADV. p 206
Paul Weir Co., Inc. 20 N. Wacker Drive Chicago 6, Ill.
Wellman Engineering Co., McDowell enterprise., 7000 Central Ave., Cleveland 4, Ohio
S. K. Wellman Co., 200 Egbert Rd., Bedford, Ohio
West Instrument Corp., 4363 W. Montrose Ave., Chicago 41, Ill.
West Virginia Armature Co., Bluefield, W. Va.
W. Va. Belt & Cable Repairs, Inc., P. O. Box 361, Mount Hope, W. Va.
West Virginia Works, Connors Steel Div., H. K. Porter Co. Inc., 17 & Second Ave., Huntington 6, W. Va.
Western Machinery Co., 650 Fifth St., San Francisco 7, Calif., ADV., Insert pp 264-265
Western Precipitation Corp., 1000 West Ninth St., Los Angeles 54, Calif.
Westinghouse Electric Corp., Gateway Center, P. O. Box 868, Pittsburgh 30, Pa. ADV. pp 251-254
Westinghouse Electric Corp., B. F. Sturtevant Div., Hyde Park, Boston, Mass.
Wheelabrator Corp., 1050 South Byrkit St., Mishawaka, Ind.
Wheeler Insulated Wire Co., Inc., Div. Sperry Rand Corp., 150 East Aurora St., Waterbury, Conn.
Wheeling Steel Corp., Wheeling Steel Bldg., Wheeling, W. Va.
White Diesel Engine Div., The White Motor Co., Springfield, Ohio ADV. p 243
Whiting Corp., Harvey, Ill.
The Whitmore Mfg. Co., 3816 Iron Court, Cleveland 4, Ohio.
Whitney Chain Co., 237 Hamilton St., Hartford 2, Conn.
Wilbur & Williams Co., 130 Lincoln St., Brighton, Boston 35, Mass.
Wilcox Mfg. Co., P. O. Box 217, Raleigh, W. Va.
Wild Heerbrugg Instruments, Inc., Main & Covert Sts., Port Washington, N. Y.
Wiley Mfg. Co., Port Deposit, Md.
A. R. Wilfley & Sons, P. O. Box 2330, Denver 1, Colo.
Williams Patent Crusher & Pulv. Co., 810 Montgomery St., St. Louis 6, Mo.
Wilson Products Div., Ray-O-Vac Co., 200 Thorn St., Reading, Pa.
Wilmot Engineering Co., 8 West Broad St., Hazleton, Pa.
L. J. Wing Mfg. Co., 303 Vreeland Mills Rd., Linden, N. J.
Winslow Government Standard Scale Works, Inc., 25 & Hawthorne Sts., Terre Haute, Ind.
Winter-Weiss Co., 2201 Blake St., Denver 5, Colo. ADV. p 260
Wire Rope Corp. of America, Inc., 609 North Second St., St. Joseph, Mo.
Wisconsin Motor Corp., Milwaukee 46, Wis.
Wise Co., O. B., P. O. Box 42, West End & Dale Ave., Knoxville 1, Tenn.
The Wood Shovel & Tool Co., Lock Drawer 818 Piqua, Ohio
T. B. Woods Sons Co., Chambersburg, Pa.
Wooldridge Mfg. Div., Continental Copper & Steel Industries, Inc., P. O. Box 127, Sunnyvale, Calif.
J. W. Woomer & Associates, 821 Oliver Bldg., Pittsburgh 22, Pa.
Worthington Corp., 421 Worthington Ave., Harrison, N. J.
Wright Power Saw & Tool Co., Sub. of Thomas Industries, Inc., 1419 Illinois Ave., Sheboygan, Wisc.
Wyandotte Chemicals Corp., Michigan Alkali Div., Wyandotte, Mich.
Wysmont Co., Inc., 42-01Q 27 St., Long Island City 1, N. Y.

Y

Yale & Towne Mfg. Co., 11000 Roosevelt Blvd., Philadelphia 15, Pa.
Yardley Plastics Co., 142 Parsons Ave., Columbus 15, Ohio
Yardney Electric Corp., 40 Leonard St., New York 13, N. Y.
Youngstown Sheet & Tube Co., Stambaugh Bldg., Youngstown 1, Ohio

Z

J. A. Zurn Mfg. Div., Zurn Industries, Inc. 1960 Pittsburgh Ave., Erie, Pa.

Coal Age

Guidebook Advertisers' District Sales Offices Distributors and/or Sales Agents

Listed Geographically for Easy Reference

This listing of sales offices, distributors and/or sales agents is designed to help Guidebook users quickly locate their nearest source of supply for manufacturers advertising in this issue. A company name in black-faced type in the Classified Product Directory (page 289) notes that more information on products offered by that manufacturer is available in advertisements on pages listed in the Directory of Manufacturers or in the Advertisers' Index on page 368.

A

ACF INDUSTRIES, INC., AMERICAN CAR & FOUNDRY DIV.

30 Church St., New York 8, N.Y.

DISTRICT SALES OFFICES

California, San Francisco 4: 111 Sutter St., Rm. 520
District of Columbia, Washington 6: 1625 K St., N.W.
Illinois, Chicago 4: 80 E. Jackson Blvd.
Missouri, St. Louis 1: 705 Olive St. Bldg.
New York, New York 8: 30 Church St.
Ohio, Cleveland 13: Terminal Tower Bldg.
Pennsylvania, Berwick 6: ACF Industries Inc.
Pennsylvania, Philadelphia 3: Suburban Station Bldg.
West Virginia, Huntington 10: P.O. Box 547

AEROQUIP CO.

Jackson, Michigan

DISTRICT SALES OFFICE

North Carolina, Greensboro: Cross Sales & Engineering Co., P.O. Box 794, 317 W. Lee St., Phone 4-1947

DISTRIBUTORS

Alabama, Birmingham:
Cummins Diesel Sales, 931 N. 7th Ave.
Mill & Mine Supply Co., 124 S. 20th St.
Alabama, Mobile: Allied Auto Parts, 265 St. Louis St.
Alabama, Montgomery 5: Dixie Trailer & Brake Service, 1625 Bell St.
Illinois, Chicago 7: Chicago Tire & Rubber Co., 850 Washington Blvd.
Illinois, Decatur: Midstate Machinery Co., 359 E. Main St.
Illinois, E. St. Louis: Illinois Electric Works, Inc., 1300-10 Missouri Ave.
Indiana, Evansville 7: Hocker Power Brake Co., 3rd & Ingle at Carpenter
Kentucky, Ashland: Ashland Plant, P.O. Box 888
Kentucky, Jenkins: National Mine Svc., Kentucky-Virginia Div., P.O. Box 872
Kentucky, Madisonville: National Mine Svc., Western Kentucky Div., 132 East Center St.
Pennsylvania, Harrisburg: Safety Sales & Service Corp., P.O. Box 1129
Pennsylvania, Indiana: National Mine Svc., Whiteman Div., 1260 Maple St.
Pennsylvania, Pittsburgh 6: The Cypher Co., 1201 Washington Blvd.
Pennsylvania, Pittsburgh 3: Tranmission Equipment Co., 1200 Muriel St.
Virginia, Harrisburg: Valley Distributors, Inc., 60 E. Rack St.
Virginia, Portsmouth: Morse-Parker Motor Supply Co., P.O. Box 587
Virginia, Norfolk:
Diesel Injection Sales & Service Inc., 808 Union
Tidewater Supply Co., 501 W. 24th St.
Virginia, Richmond:
Cummins Diesel Sales & Service, P.O. Box 9426
Standard Parts Corp., 1017 W. Graham Rd.
Virginia, Roanoke:
Standard Parts Corp., Williamson Rd.
Tidewater Supply Co.
Virginia, Salem: Diesel Injection Sales & Service, Inc., 412 8th St.
Virginia, Winchester: Valley Distributors Inc.
West Virginia, Beckley: National Mine Svc., Bemeco Div., P.O. Box 32
West Virginia, Bluefield: Bluefield Hardware Co.
West Virginia, Logan: National Mine Svc., All-State Div., P.O. Box 1671
West Virginia, Charleston:
A&I Supply Co., 614 Virginia St. West
Capital City Supply Co., Broad & Smith St.
Cummins Diesel Sales & Svc. Inc., Box 527
Kanawha Steel & Equipment Co., Clark & Welch St.

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West Virginia, Fairmont: Fairmont Supply Co., 10th & Belt Lane

West Virginia, Weirton: Kanawha Steel & Equipment Co., 112 24th St.

West Virginia, Wheeling: Wheeling Rubber Products Inc., 841 Market St.

West Virginia, Williamson: Persinger Supply Co.

AJAX FLEXIBLE COUPLING CO., INC.

Westfield, N.Y.

DISTRIBUTORS

Alabama, Birmingham 4: S. L. Morrow Engineering Co. 113 North 9th St., Phone 4-6225

Illinois, Chicago 18: R. R. Baumann, 2447 W. Belmont Ave., WEllington 5-9440

Indiana, Indianapolis 2: A. R. Young Co., Inc., 520 North Dorman St. MElrose 6-6351

Kentucky, Louisville 3: Alfred Halliday Co., Inc., 719-721 S. Preston St., JUniper 2-2462

Missouri, St. Louis 4: Capstick & Co., 2337 South 13th St., MOhawk 4-4567

Pennsylvania, Pittsburgh 19: J. Guy Griffith Co., 1251 Union Trust Bldg., ATlantic 1-3854

Pennsylvania, Upper Darby: George Kelso, 7046 Garrett Rd., FLanders 2-1350

Washington, Seattle 4: Stephen Thurlow Co., Room 203, 1731 First Ave. So., MUtual 5488

ALDON CO.

3338 Ravenswood Ave., Chicago, Ill.

ALLEGHENY LUDLUM STEEL CO., CARMET DIV.

1500 Jarvis Ave., Detroit, Mich., JOrdan 4-6900

DISTRIBUTORS

Alabama, Birmingham: Crandall Engineering Co., Inc.

Colorado, Denver: Union Supply Co.

Indiana, Evansville: Drillmaster Supply & Mfg. Co.

New Mexico, Carlsbad: Carlsbad Supply Co.

Ohio, St. Clairsville: Oglebay, Norton Mine Supply Div.

Oklahoma, McAlester: Gladstein Co.

Oklahoma, Picher: Consolidated Supply Co.

Pennsylvania, Charleroi: Oglebay, Norton Mine Supply Div.

Pennsylvania, Johnstown: Oglebay, Norton Mine Supply Div.

Pennsylvania, Leechburg: Leechburg Supply Co.

Pennsylvania, Pittsburgh: U. S. Steel Supply Co.

Tennessee, Jellico: McCombs Supply Co.

Tennessee, Whitewell: Marion Mine & Mill Supply Co.

Utah, Helper: Carbon Transfer & Supply Co.

West Virginia, Charleston: Persinger's Inc.

West Virginia, Williamson: Persinger Supply Co.

ALLEN & GARCIA CO.

322 S. Michigan Ave., Chicago 4, Ill.

ALLIS-CHALMERS MFG. CO.

Box 512, Milwaukee 1, Wis.

DISTRICT SALES OFFICES

Alabama, Birmingham 3: Brown-Marx Bldg., 200 1st Ave., N., Phone 4-5494

Illinois, Chicago 3: 135 S. LaSalle St., FRanklin 2-6480

Illinois, Chicago 41: 3254 N. Kilbourn Ave., (General Purposes Equipment Sales), MUlberry 5-6614

Illinois, Peoria: Commercial Nat'l Bank Bldg. Phone 4-9279

Indiana, Evansville 9: Citizens Nat'l Bank Bldg., 329 Main St., HArrison 48219

Kentucky, Louisville: Kentucky Home Life Bldg., 241 S. 5th St., CLay 7656

Missouri, St. Louis 3: 1205 Olive St., CEntral 1-4313

Ohio, Cincinnati 2: Enquirer Bldg., 617 Vine St., MAin 7300

Ohio, Columbus: Kingswood Bldg., 1384 Grandview Ave., HUdson 6-2465

Ohio, Youngstown 3: 25 E. Boardman St., RIverside 3-5175

Pennsylvania, Pittsburgh 19: 421 7th Ave., ATlantic 1-7279

Pennsylvania, Wilkes-Barre: Market & Franklin Sts., VAlley 3-2413

Pennsylvania, York: 42 E. King St., York 5415

Tennessee, Knoxville 2: 531 S. Gray St., Phone 2-2165

West Virginia, Charleston 1: Peoples Bldg., 179 Summers St., Phone 39505

DISTRIBUTORS

Alabama, Birmingham:
Alabama Electric Repair & Service, 2411 1st Ave., Phone 7-8121
Mill & Textile Supply Co., Inc., 3130 3d Ave., ALpine 1-8187
Tuscaloosa Electric Supply Co., 1616 25th Ave., Phone 6671
Shook & Fletcher Supply Co., 1814 1st Ave. N., Phone 3-6261
Young & Vann Supply Co., 1729-31 1st Ave., N., P.O. Box 2532, Phone 7-5161

Alabama, Dothan: Alabama Electric Co., 215 E. Troy St., Phone 2-4850

Alabama, Montgomery: Standard Electric Co., 515 N. Decatur, Phone 4-2276

Illinois, Cairo: Simmons Supply & Machine Works, 210-214 Commercial Ave., Phone 220 or 599

Illinois, Chicago:
Chicago Electric Co., 1318 W. Cermak Rd., CAnal 6-2900
Dodge Chicago Industrial Equipment Co., 330 E. 24th St. CAlumet 5-8500
Electric Supply Corp., 701 W. Jackson Blvd., AN 3-5225
Franklin Supply Co., 624 S. Michigan Ave., WEbster 9-0811
Sievert Electric Co., 1347 Bauwans St., ARmitage 8300

Illinois, Decatur: Illinois Bearing Co., 827 N. Broadway, Phone 3-3471

Illinois, Galesburg: Galesburg Electric Supply Co., 550 S. Cedar St., Phone 7466-3

Illinois, Joliet: Keck's Electric Corp., 201 N. Bluff St., Joliet 3-1006

Illinois, Marion: Giles Armature & Electric, Inc., 701 Stockton-Works St., Phone 681

Illinois, Peoria: Paul J. Hagerty Equipment Co., 800 S. Adams St., Phone 42188

Illinois, Springfield: Matlin Corp., 2410 S. MacArthur, Phone 8-5101 & 8-6259

Indiana, Evansville: Drill Master Supply Co., 117 E. Division St., Phone 3-5481

Indiana, Hammond:
Electric Supply Corp., 4511 Calumet Ave.
Southern Electric Inc., 5025 Columbia Ave., Sheffield 5500

Kentucky, Harlan: National Electric Service Corp., Phone 754

Kentucky, Louisville:
Neill-LaVielle Supply Co., Inc., 2211 S. Brook St., Melrose 7-5401
Southland Electric Supply Co., Inc., 512 W. Main St., WA 3159

Missouri, St. Louis:
American Iron-Steel Mfg. Co., 5577-79 Manchester Ave., MO 6522
Essmeller Co., 1220 S. 8th St., CHestnut 3223.
Kahn Electric Co., 1024 Charlieville Place, RE 4631
Tools & Supplies, 3131-3137 Olive St., FRanklin 3370

Ohio, Cincinnati:
Barkley Electric Co., 4817 Industrial Court, PA 0400
Busch-Lawrence Co., 2157 Barnard St., Parkway 0783
Cincinnati Electric Equipment Co., 16 E. 72 St., MA 2127
Ernest Equipment & Supply Co., 829 National Ave., Phone 3-2674
F. D. Lawrence Electric Co., 217-219 W. 4th St., Cherry 6800
General Factory Supplies Co., Inc., 1167 Harrison Ave., Garfield 1-1616

Ohio, Columbus:
Electric Motor & Control Corp., 55-51 E. Chestnut St., CA 4-5215

Ohio, Dayton: Martin Electric Co., 310 E. 2d St., Fulton 5141

Ohio, Marietta: McJunkin Corp., 201-14 United Carbon Bldg., Phone 2646

Ohio, Youngstown:
Winkle Electric Co., 201 Andrew Ave., Phone 3-3124

Pennsylvania, Altoona: Blair Electric Service Co., 3108 Pleasant Valley Blvd., PH 4-1646

Pennsylvania, Johnstown: M. Glosser & Sons, 80 Messenger St., Phone 81296

Pennsylvania, New Castle: S. H. Byers Equipment Co., 402 Sampson, Phone 8008

Pennsylvania, Pittsburgh:
Carmac Equipment Co., 1015 Peralter St., FAirfax 2-1230
W. T. McCullough Electric Co., 416 1st Ave.
Mosebach Electric & Supply Co., 115 Arlington Ave., HE-8332
Transmission Equipment Co., 1200 Muriel St., HE 1-2100
West Virginia Electric Corp., 208 Newton St., Phone 3473
Wheeling Rubber Products Inc., 927 Market St., Phone 1220

Pennsylvania, Pittston: Medico Electric Motor Co., 11 Tompkins St., Pittston, OL 4-6711

Pennsylvania, Williamsport: G.I. Electric Co., 134 E. Willow St., Phone 3-6147

Pennsylvania, York: Bush-Miller Inc., 320 N. George St., York 7508

Tennessee, Kingsport:
Wholesale Electric Inc., P.O. Box 45-448 Reedy St., Circle 7-7151

Tennessee, Knoxville:
Browning Belting & Supply Co., 216-218 N. Central Ave., Phone 3-9101
Roden Electric Supply Co., 808 N. Central Ave., Phone 3-0491

Tennessee, LaFollette: Standard Armature Works Inc., Box 432, Phone 292ML

Virginia, McClure: Erwin Supply & Hardware Co., Inc., Phone Clinchco 2311

Continued

ALLIS-CHALMERS . . . Cont'd

West Virginia, Bluefield: Bluefield Hardware Co., Inc., 400-420 Bluefield Ave., Phone 5131
West Virginia, Charleston: Charleston Electrical Supply Co., 912-914 Kanawha Blvd., Phone 26-157
Tri-State Air Cond. Div. of R. H. Kyle & Co., 1216 Smith St., Phone 3-9589
West Virginia, Parkersburg: Mid-Valley Supply Inc., 323 Ann St., HUdson 5-5569
West Virginia, Shinnston: Erwin Supply Co., Inc., Phone Shinnston 479

AMERICAN AIR FILTER CO., INC.

Louisville 8, Ky.

DISTRIBUTORS

Illinois, Chicago 1: Air Filter & Equipment Co., 228 N. LaSalle St.
Kentucky, Louisville 2: H. M. Lutes Assoc., 633 S. 5th St.
Missouri, St. Louis 10: C. H. Burnap Co., 4030 Chouteau Ave., 312 Chouteau Bldg.
Pennsylvania, Pittsburgh 42: American Air Filter Co. Inc., 5907 Penn Ave.
West Virginia, Charleston 24: Mechanical Products Co., P.O. Box 1143, 303-29th St. S. E.

AMERICAN CYANAMID CO., EXPLOSIVES DEPT.

30 Rockefeller Plaza, New York 20, N.Y.

DISTRICT SALES OFFICES

Missouri, St. Louis 10: 5025 Pattison Ave.
Pennsylvania, Latrobe: P. O. Box 270
Pennsylvania, Pottsville: 209 North 19th St.
Pennsylvania, Scranton: 1102 Scranton National Bank Bldg.
West Virginia, Bluefield: Bradmann Bldg., P. O. Box 219

AMERICAN MINE DOOR CO., THE

2057 Dueber Ave. S. W., Canton 6, Ohio, GLendale 4-7055

DISTRIBUTORS

Alabama, Birmingham: J. T. Sudduth & Co., 3017 Sixth Ave., S., Phone 7-6101
Colorado, Denver 16: Union Supply Co. 5460 Colorado Blvd., AMherst 6-2292
Kentucky, Madisonville: Robert A. Thompson, c/o Madison Hotel, Phone 812
Michigan, Ishpeming: Charter Inc., 155 S. 1st St., HUdson 6-4471
Pennsylvania, Hazleton: Barrett Haentjens Sales Co., 225 North Cedar St., Phone GL 4-0837
Utah, Salt Lake City: National Equipment Co., 101 W. 2nd S. St., EMpire 3-8878

AMERICAN MINE SUPPLY CO.

404 Frick Bldg., Pittsburgh 19, Pa., GRant 1-0276

DISTRIBUTORS

Alabama, Birmingham 8: National Mine Service Co., 2602 15th St., Ensley
Illinois, Mt. Vernon: Central Mine Supply Co., 218 S. 3rd St.
Kentucky, Jenkins: National Mine Service Co., P.O. Box 872
Kentucky, Madisonville: Central Mine Supply Co., P. O. Box 30
National Mine Service Co., 132 E. Center St.
Pa. Pittsburgh 21: Wallis & Co., P. O. Box 8643
Pa., Forty-fort: National Mine Service Co., 153 Wells St.
Utah, Salt Lake City 1: Western Sales Engineering Co., 375 South West Temple
West Virginia, Beckley: National Mine Service Co., P. O. Box 30
West Virginia, Logan: National Mine Service Co., P. O. Box 1671

AMERICAN PULVERIZER CO.

1275 Macklind Ave., St. Louis, Mo.

DISTRIBUTORS

Georgia, Atlanta 3: J. B. Frescoln, 716 Walton Bldg.
Illinois, Chicago 5: Mayer & Oswald Inc., 417 S. Dearborn
Kentucky, Louisville: Alfred Halliday Co., Inc., P.O. Box 756
Missouri, Kansas City 12: W. C. Carolan Co., 612 W. 47th St.
North Carolina, Charlotte 3: A. M. Stephenson, 1366 E. Morehead St.
New York, New York 17: Howard L. Hill, 101 Park Ave.
Ohio, Cincinnati 2: W. W. Baerbalck & Associates, 1427 Beaverton Ave.
Ohio, Cleveland 3: Stephan Co., 7016 Euclid
Pennsylvania, Cheltenham: C. B. McQuarry, Box 52
Pennsylvania, Pittsburgh 22: Titzel Engineering & Equipment Co., 132 7th St., 952 Century Bldg.

AMERICAN STEEL & WIRE DIV. UNITED STATES STEEL CORP.

Rockefeller Bldg., Cleveland 13, Ohio

DISTRICT SALES OFFICES

Colorado, Denver: First Nat. Bank Bldg., MAin 2241
Illinois, Chicago: 208 S. LaSalle St., CEntral 6-9200
Missouri, Kansas City: Power & Light Bldg., GRand 1-2050
Missouri, St. Louis: 1221 Locust St., CEntral 1-1277
New York, New York: 71 Broadway, DIgby 4-9000
Ohio, Cincinnati: Fifth-Third Bank Bldg., Garfield 1-4460
Ohio, Cleveland: Rockefeller Bldg., TOwer 1-2000
Pennsylvania, Philadelphia: Suburban Station Bldg., LO 4-4000
Pennsylvania, Pittsburgh: 525 William Penn Pl., EXpress 1-2345

DISTRIBUTORS

Alabama, Fairfield: Tennessee Coal & Iron Div., U.S.S., Phone 6-8011
California, San Francisco: Columbia Geneva Steel Division, U.S.S., 120 Montgomery St., Sutter 1-2500
New York, New York: U.S.S. Export Co., 30 Church St., COrtland 7-7474

ANACONDA WIRE & CABLE CO.

25 Broadway, New York 4, N. Y.

DISTRICT SALES OFFICES

Colorado, Denver 2: 706 Railway Exchange Bldg., AComa 2-0616
Georgia, Atlanta 3: 1915 Rhodes-Haverty Bldg., JAckson 5-2062-3-4
Illinois, Chicago 6: 20 N. Wacker Dr., FRanklin 2-5200
Indiana, Indianapolis: 720 Circle Tower, MElrose 8-3484
Missouri, St. Louis 8: 400 Continental Bldg., JEfferson 1-0505-6
Ohio, Cincinnati 2: 3903 Carew Tower, MAin 1-3216
Ohio, Cleveland 6: 10623 Chester Ave., SWeetbriar 1-2301
Pennsylvania, Philadelphia 3: 1616 Walnut St. Bldg., Pennypacker 5-8118
Pennsylvania, Pittsburgh 22: 1526 Bldg. No. 3, Gateway Center, ATlantic 1-4260-1
West Virginia, Charleston 1: 501 Peoples' Bldg. Phone 35-527-8

Who Makes What . . . Where Are They?

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1957 edition.

Manufacturers advertising in this issue appear in bold-face type in the Buying Directory. You'll find more helpful product information in their advertisements.

COAL AGE'S MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an annual service for all COAL AGE subscribers

ATHEY PRODUCTS

5631 West 65th St., Chicago 38, Ill., Portsmouth 7-6363

DISTRIBUTORS

Caterpillar Dealers

ATLAS POWDER COMPANY

Wilmington 99, Del.

DISTRICT SALES OFFICES

Colorado, Denver: 2390 S. Delaware St., SHerman 1747
Illinois, Chicago: 1606 Field Bldg., 135 S. La Salle St., FRanklin 2-9530
Missouri, Joplin: 612 First National Bldg., MAyfair 4-0924
Pennsylvania, Pittsburgh: 1544 Oliver Bldg., ATlantic 1-2684
Pennsylvania, Tamaqua: 601 Schuylkill Ave., Phone 1300
Pennsylvania, Wilkes-Barre: 1026 Miners Bank Bldg., VAlley 3-2516
Tennessee, Knoxville: 813 Hamilton National Bank Bldg., Phone 2-2147
Utah, Salt Lake City: 823 Continental Bank Bldg., Phone 4-7064
Washington, Seattle: 1320 Joseph Vance Bldg., MAin 5110

DISTRIBUTORS

Illinois, Lenzburg: Superior Explosives Co., New Athens III-215
Illinois, Marion: Superior Explosives Co., c/o Mr. Ed Cash, 511 E. Main, Phone 834
Illinois, Quincy: Quincy Supply Co., 700 S. Front St., BAldwin 3-1171
Indiana, Brazil: Hoosier Explosives Co., 26-28 S. Walnut St., Phone 2391
Indiana, New Albany: C. L. Graf, Inc., 316 State St., Phone 4-1113
Kentucky, Barbourville: Blair-Noonan Co.
Kentucky, Dorton: Dorton-Atlas Supply Co.
Kentucky, Lothair: Speck Cornett
Kentucky, Martin: Reed & Dingus Explosive Co., Box 226
Kentucky, Middlesboro: Reams Hardware, Phone 89
Kentucky, Prestonburg: Prestonburg Explosive Co., Phone 3261
Ohio, Blaine: Henry Rehm
Ohio, Canton: Apex Powder Corp., 1545 Waynesburg Rd, S. E.
Ohio, Oak Hill: Oak Hill Powder Supply Co.
Pennsylvania, Brockway: Beadle Corp.
Pennsylvania, Clarion: Amos L. Dolby
Pennsylvania, Clearfield: Clearfield Hardware Co., Inc.
Pennsylvania, Clymer: Longwill Mine Supply Co., 56 Morris St.
Pennsylvania, Hastings: James McNelis
Pennsylvania, Hopewell: F. M. Zeth Co.
Pennsylvania, Johnstown: Cambria Drilling Co., 270 Susquehanna St.
Pennsylvania, Listie: Edward Steinkirchner
Pennsylvania, Meyersdale: Shipley Hardware Co.
Pennsylvania, Ramey: Williams Powder Co.
Pennsylvania, Tyler: Patsy Georgino & Son
Pennsylvania, Sidman: George H. Miller
Pennsylvania, Uniontown: George F. Buerger, 656 Bierer Lane
Tennessee, La Follette: Card Explosive Co., Phone 85
Tennessee, Monterey: Monterey Hardware Co.
Tennessee, Whitwell: Marion Mine & Mill Supply Co.
Virginia, Big Rock: Buchanan Wholesale Co.
Virginia, Grundy:
Bevins-Atlas Co., P.O. Box 1168
Richlands Explosives Co., Box 1027
Virginia, Norton: Farmer Feed Co.
West Virginia, Bluefield:
Bluefield Hardware Co., 400 Bluefield Ave.
Bluefield Supply Co, 100 Mercer St. Phone 6121
Enterprise Trucking Co. Phone 4601
Superior-Sterling Co., 200 Bluefield Ave.
West Virginia, Chattaroy: Falls Branch Market
West Virginia, Charleston: W.Va. Explosives Co., Phone 4-5521
West Virginia, Clarksburg: Atlas Supply & Equip. Co., 309 N. 4th St.
West Virginia, East Rainelle: Greenbrier Explosive Co., Phone 4601
West Virginia, Lewisburg: Midland Explosives & Equipment Co.
West Virginia, Sutton: A. L. Rose & Co.

AUSTIN POWDER CO.

Cleveland 13, Ohio, MAin 1-0303

DISTRICT SALES OFFICES

Indiana, Evansville: 616 N.W. Second St., HA 4-8275
Pennsylvania, Waynesburg: P.O. Box 388

SALES AGENTS

Illinois, Canton: Jerry Downey, 131 West Olive St., Phone 4031
Illinois, Carrier Mills: Robert Bramlet, R.D. 1, Phone 39-F14
Illinois, Eldorado: Paul Horton, 2101 Main St., BR 3-4598
Indiana, Boonville: Perry Corn, Phone 567
Indiana, Evansville: Edgar Becker, Ben Hatley, Maurice L. Jones, and Clark Wilkinson, 616 N. W. Second St., HA 4-8275
Indiana, Linton:
Radford Brown, Phone 953R1
Richard L. Jones, 490 F St., N.E., Phone 1381
Kentucky, Henderson: Jack Eddins, VA 7-3425
Kentucky, Hodgenville: C. L. Hughes, P. O. Box 4, EL 8-3464
Kentucky, Jackson: Gilbert Trail, Box 42, NO 6-2433
Kentucky, Madisonville: Edward Callaway, Thomas J. King, and Donald Lyons, Phone 2244
North Carolina, Raleigh: W. W. Clark, 2708 St. Mary's St., TE 2-1838
Ohio, Bellaire: V. W. Allen, P.O. Box 379 ME 3-9373
Ohio, Columbus: A. A. Mellin, 119 Aldrich Rd., AM 2-7246
Ohio, Mentor: Larry Strimple, R. D. #1, 315 Liberty, BL 7-7494
Pennsylvania, Philipsburg: George Humphrey, P.O. Box 96, Phone 680J
Pennsylvania, Pittsburgh:
Robert Chorpenning, 1334 Prospect Rd., TU 2-8423
Russell E. Loach, 266 Constitution Dr., OL 5-7964
Ronald Smith, 6741 McPherson Blvd., EM 1-0821
Pennsylvania, Scranton: W. J. Raeder, 148 Adams Ave., DI 2-0169
Pennsylvania, Six Mile Run: M. H. McMillin, Phone Hopewell, Pa. 8-2703
Tennessee, Memphis: J. W. Torrey, 88 E. McKellar St., WH 8-0626
Tennessee, Nashville: L. F. L'Donohoe, 219 Cherokee Rd., AM 9-1872
Virginia, Grundy: C. S. Schubert, P.O. Box 175, WE 5-5221
Virginia, Norton: J. M. Wilson, P.O. Box 40, Phone #105
West Virginia, Chapmanville: T. J. Wilding, P.O. Box 110, UL 5-4521
West Virginia, Charleston: W. B. Craver, Jr., 933 Churchill Circle, DI 6-1663
West Virginia, Clarksburg: Richard D. Rawson, 210 N. Chestnut St., Apt. C, MA 2-3873
West Virginia, Mount Hope: Joe Trail, P.O. Box 42, Phone 3
West Virginia, Welch: William Gergely, Bramwell 386-A

AUSTIN-WESTERN CONSTRUCTION EQUIPMENT DIV., BALDWIN-LIMA-HAMILTON CORP.

Aurora, Ill.

DISTRIBUTORS

Alabama, Birmingham 1: Joe Money Machinery Co., Inc., P. O. Box 1389, 903 Third Avenue West, Phone 58-6501
Alabama, Chickasaw: May-Money Machinery Co., Drawer R, Telegraph Road, Phone Mobile—HEmlock 3-9559
Arkansas, Fort Smith: R. A. Young & Son, Inc., 301 South Tenth St., SUnset 3-8901
Arkansas, Little Rock: R. A. Young & Son, Inc., 5th and Rector St., FRanklin 2-0172
Colorado, Denver 16: Macdonald Equipment Co., 5300 Colorado Blvd., AMherst 6-2641
Georgia, Atlanta 18: R. S. Armstrong & Bro. Co., 676 Marietta St., N.W., JAckson 4-6434
Illinois, Peoria 2: R. E. Common Equipment Co., 1515 South Washington St., Phone 6-8778
Indiana, Petersburg: Fred Malotte Machinery Co., Inc., P.O. Box 34, Main St., Phone 98
Iowa, Des Moines 9: Hawkeye Machinery Co., 1225 Walnut St., ATlantic 2-0244
Missouri, Kansas City 8: Buchanan Equipment Co., 2645 Southwest Blvd., VAlentine 1-5903
Missouri, St. Louis 10: Machinery, Inc., 5081 Manchester Ave., JEfferson 5-2056
Montana, Billings: Hall-Perry Machinery Co., P.O. Box 1975, 902 Central Ave., Phone 6-6864
North Carolina, Charlotte 1: H. B. Owsley & Son, Inc., P.O. Box 449, Pineville Rd., FRanklin 6-8444
North Dakota, Minot: Northwestern Equipment Co. of Minot, P.O. Box 152, U.S. Highway 52 West, Phone 69-111
North Dakota, Bismarck: Northwestern Eqpt., Inc., 1522 Main Ave.
Ohio, Cincinnati 24: Flack Equipment Co., 2565 W. Galbraith Rd., JAckson 1-7558
Ohio, Cleveland 11: W. T. Walsh Equipment Co., 12750 Berea Rd., CLearwater 2-4660
Ohio, Cleveland 30: Cleveland Contractors Equipment Co., 10904 Brookpark Rd., Shadyside 1-5570
Ohio, Columbus 7: Columbus Equipment Co., 50 E. Kingston Ave., HIckory 3-6541
Ohio, Columbus 22: Lorenz Equipment Co., 547 West Rich St., CApital 8-2647
Ohio, Toledo 4: Construction Machinery & Supply Co., Inc., 128 South St. Clair St., CHerry 3-4126 & 3-4127
Oklahoma, Enid: Bert Smith Road Machinery Co. Inc., P.O. Box 1266, 321 West Chestnut St., ADams 4-4950
Oregon, Portland 14: Columbia Equipment Co., 1240 S. E. 12th Ave., BElmont 2-7148

Continued

AUSTIN-WESTERN . . . Cont'd

Pennsylvania, Carnegie: John W. Patterson Co., P. O. Box 515, 128 Hanover St., Rook Station, BRowning 9-3500
Pennsylvania, Franklin: State Equipment Co., 655 Grant St., IDlewood 2-2115
Pennsylvania, Harrisburg: Stephenson Equipment Inc., Box 69—Hill Station, 4200 Chambers Hill Road, CEdar 8-4220
Pennsylvania, Philadelphia 43: Stewart Equipment Co. of Phila., Inc., 52nd St. and Woodland Ave., SAratoga 7-1611
South Dakota, Rapid City :Houston Equipment Co., P.O. Box 284, 324 East Blvd., FIllmore 2-5394
South Dakota, Sioux Falls: Stan Houston Equipment Co., Inc., P.O. Box 857, 2514 South Minnesota Ave. on U.S. 77, Phone 4-5605
Tennessee, Chattanooga 1: Nixon Machinery & Supply Co., Inc., 1300 Carter St., Phone 7-5573
Tennessee, Knoxville: Nixon Machinery & Supply Co., Inc., 3042 North Central Ave., Phone 2-3111
Tennessee, Memphis 7: Hawkins Equipment Co., P.O. Box 4695, 1475 Thomas St., JAckson 5-5747
Tennessee, Nashville: Nixon Machinery & Supply Co., Inc., P.O. Box 176, 1211 Demonbreun St., ALpine 5-5688
Texas, Dallas 1: Hi-Way Machinery Co., 3612 Commerce St., TAylor 4-5168
Utah, Salt Lake City 15: Western Machinery Co., Box 2548, 2300 South Main St., INgersol 6-8668
Virginia, Richmond 27: Capital Equipment Co., Inc., P.O. Box 9246—Bellevue Station, 2050 Westmoreland St., Phone 5-1789
Washington, Seattle: Columbia Equipment Co., 5030 First Ave., South, LAnder 1530
Washington, Spokane: Columbia Equipment Co., North 1007 Freya St., KEystone 4-1581
West Virginia, Huntington 3: Porter Supply Co., Inc., P.O. Box 736, 1703 Seventh Ave., Phone 2-6651
Wyoming, Casper: Keremi Tractor & Equipment Co., Box 519, 414 South Elm St., Phone 3-6631

B

B-I-F INDUSTRIES, INC.

325 Harris Ave., Providence 1, R.I., Gaspee 1-4302

DISTRICT SALES OFFICES

District of Columbia, Washington 11: Allison Bldg., 6230 3d St. N.W., Tuckerman 2-9026
Illinois, Chicago 45: 2039 W. Howard St., Hollycourt 5-7964
Missouri, Kansas City 11: 406 W. 34th St., Suite 928-9, Jefferson 1-8080
Pennsylvania, Oakmont: 314 Allegheny River Blvd., Oakmont 1814
Pennsylvania, Philadelphia 44: 402 Chelten Ave., Victor 8-5100
Texas, Dallas: (B-I-F Texas Inc.) 4520 N. Central Expressway, Taylor 9690
Texas Houston 6: (B-I-F Texas Inc.) 2435 N. Blvd., Jackson 6-1335
Wisconsin, Milwaukee 8: 1348 N. 37th St., West 3-1991

DISTRIBUTORS

Colorado, Denver 2: Ambler Co., 325 Denver Nat. Bank Bldg., Tabor 5-8885
Georgia, Atlanta 3: Evans L. Shuff & Assoc., Inc., 310 5 Ivy St. Bldg., Lamar 0291
Illinois, Moline: Zimmer & Francescon, 1715 15-St. Place, Moline 4-3576
Missouri, St. Louis 1: Lane Machinery Co., 7th & Market Sts., Buder Bldg., Central 1-0011
Nebraska, Omaha 8: Bert Gurney & Assocs., 1112½ Farnam St., Jackson 8445
Ohio, Cincinnati 2: H. T. Porter Co., 1425 Union Central Bldg., Main 1298
Ohio, Cleveland 14: H. R. Bowers Co., 1059 Leader Bldg., Main 1-2860
Oklahoma, Tulsa 9: Arduser & Co., 303 S. Frankfort, Gibson 7-8311
Oregon, Portland 10: R. H. Brown & Co., 5825 N.W. Front Ave., Cap. 7-1155
Tennessee, Nashville 3: Allen-Shuff Corp., 300-2 Tuck Bldg., 1121 Church St., Alpine 6-7795
Texas, Amarillo: Lewis Dodson Engr. Co., 75 Hughes St., Drake 2-1075
Texas, San Antonio 6: Texas Filter Co., Inc., 300 Blum St., Capital 6-6291
Utah, Salt Lake City 16: J. Henry Jones Co., 20 Apricot Ave., Phone 5-4191

BIN-DICATOR CO.

13946 Kercheval St., Detroit 15, Mich.

BIXBY-ZIMMER ENGINEERING CO.

961 Abingdon St., Galesburg, Ill.

BOWDIL CO., THE

Boylan Ave. S.E., Canton 7, Ohio, GLendale 6-7176

DISTRICT SALES OFFICES

Colorado, Denver: Wm. Radcliff, 761 Steele St., Phone EA 2-7151
Illinois, West Frankfort: Randal A. Leach, 1004 E. St. Louis St., Phone 675
Ohio, Magnolia: C. W. Weisburn, Phone UN 6-2166
Pennsylvania, Perryopolis: J. M. Blasco, North Liberty Ave., Phone Redfield 6-2575
Kentucky, Whitesburg: A. J. Leach, Sand Lick Rd., Phone 2232
West Virginia, Danville: E. D. Caudill, Box 132, Phone 810
Utah, Helper: V. L. Walkington, Phone 144
Canada, Drumheller, Alberta: Western Distributors Co.

BUILDERS PROVIDENCE, INC., DIV. of B-I-F INDUSTRIES, INC.

(See B-I-F Industries, Inc. for detailed listing)

BUTTNER WORKS, INC.

52 Vanderbilt Ave., N. Y. 17, N. Y.

DISTRICT SALES OFFICES

Canada, Montreal, Quebec: Buttner-Works (Canada) Ltd., Box 688

C

CARDOX CORP.

307 N. Michigan Ave., Chicago 1, Ill.

DISTRICT SALES OFFICES

Colorado, Louisville: Boulder-HIllcrest 2-8636
Illinois, Benton: Box 537, BEnton 8-3821
Indiana, Evansville: 307 N.W. 5th St., Box 84, HArrison 2-8944
Iowa, Ottumwa: Ottumwa-MUrray 4-6564
Kentucky, Pikeville: Route 2, Box 571, Robinson Creek #5
Ohio, St. Clairsville: Box 1, St. Clairsville 619
Pennsylvania, Library: Box 427, TEnnyson 5-6910
West Virginia, Camden-on-Gauley: Camden-on-Gauley 2181
West Virginia, Harper: CLifford 3-4812

CENTRIFUGAL & MECHANICAL INDUSTRIES, INC.

146 President St., St. Louis 18, Mo., PR 6-2848

DISTRICT SALES OFFICE

West Virginia, Huntington: 925-6th Ave., Huntington 4-4131

CHEATHAM ELECTRIC SWITCHING DEVICE CO.

4780 Crittendon Dr., Louisville 9, Ky., EMerson 3-3571

CHICAGO PNEUMATIC TOOL CO.

6 East 44th St., New York 17, N. Y.

CINCINNATI MINE MACHINERY CO., THE

Cincinnati 25, Ohio

DISTRIBUTORS

Alabama, Birmingham: J. T. Sudduth & Co., P.O. Box 3123 Avondale Station
Colorado, Denver: Union Supply Co., P.O. Box 6735 Stockyard Station
Illinois, Benton: W. M. Hales Co., Box 303
Illinois, Chicago: W. M. Hales Co., 605 W. 116th St.
Illinois, Danville: W. M. Hales Co., Box 65
Illinois, Hillsboro: W. M. Hales Co., Box 356
Illinois, West Frankfort: W. M. Hales Co., Box 239
Kentucky, Harlan: McComb Supply Co.
Kentucky, Madisonville: W. M. Hales Co., Box 91
Pennsylvania, Johnstown: Penn Machine Co., Station St.
Pennsylvania, Pittsburgh: Penn Machine Co., Union Trust Bldg.
Tennessee, Jellico: McComb Supply Co.
Utah, Kenilworth: Frank Armstrong
West Virginia, Huntington: Huntington Supply & Equipment Co., Box 370
Canada, Alberta, Drumheller: Gorman's Ltd.
Canada, Alberta, Edmonton: Gorman's Ltd.
Canada, New Brunswick, St. John: E. S. Stephenson & Co., 15 Dock St.
Canada, Nova Scotia, Halifax: E. S. Stephenson & Co., P.O. Box 1033
South Africa, Durban: F. G. Licence (Pty) Ltd., P.O. Box 1362

COMBUSTION ENGINEERING, INC., RAYMOND DIV.

1315 N. Branch St., Chicago 22, Ill.

DISTRICT SALES OFFICES

North Carolina, Charlotte 3: 518 E. Morehead St.
Ohio, Cincinnati 2: 1101 Enquirer Bldg.
Ohio, Cleveland 14: Nat'l City Bank Bldg.
Pennsylvania, Philadelphia 3: 1616 Walnut St.
Pennsylvania, Pittsburgh 22: 1 Gateway Center

COMPTON, INC.

P.O. Box 1946, Clarksburg, W. Va.

D

DANIELS CO., THE, CONTRACTORS, INC.

22 N. 5th St., Indiana, Pa., INdiana 5-7189 & 5-7198

DISTRICT SALES OFFICES

New Jersey, Newark
West Virginia, Bluefield

DART TRUCK CO.

Kansas City 8, Mo., HA 6170

DISTRIBUTORS

Alabama, Birmingham: Leary & Owens Machine Co., 3600 5th Ave.
Alabama, Montgomery: Leary & Owens Equipment Co., 3165 Mobile Rd.
Georgia, Atlanta: W. C. Kaye & Co., Inc., 787 Windsor St. S.W.
Illinois, Oaklawn: Tractor & Equipment Co., 10000 S. Ridgeland Ave.
Indiana, Indianapolis: Seastrom & Co., Inc., 2357 Kentucky Ave.
Missouri, Kansas City: Funkhouser Equipment Co., 2425 Jefferson St.
North Carolina, Winston-Salem: J. W. Burress, 100 Waughtown St.
Ohio, Cleveland: Cleveland Contractors Equipment Co., 10904 Brookpark Rd.
Oregon, Portland 14: Balzer Machinery Co., 2136 S.E. 8th Ave.
Pennsylvania, Philadelphia 32: Service Supply Corp., 2020 W. Erie Ave.
Pennsylvania, Philadelphia 40: Austin Supply Co., 20th and Venango
Pennsylvania, Pittsburgh 29: Watson Eqpt. Co., P.O. Box 9707
Tennessee, Nashville: McCarthy-Jones & Woodard, 723 Argyle Ave.
Texas, Dallas 19: Lumby Machine Co., 6541 Forest Park Rd. at Mockingbird Lane
Utah, Salt Lake City 10: Arnold Machinery Co., Inc., P.O. Box 2220
Virginia, Roanoke: Southern Machinery Co., 2745 Shenandoah Ave. N.
West Virginia, Charleston: West Virginia Tractor & Equipment, P.O. Box 473

DENVER EQUIPMENT CO.

1400 17th St., Denver 17, Colo., CHerry 4-4466

DISTRICT SALES OFFICES

Colorado, Colorado Springs: 500 S. Sewatch St., MElrose 3-7158
Illinois, Chicago 1: Bell Bldg., CEntral 6-2423
New York, New York: Empire State Bldg., CHickering 4-6510
Utah, Salt Lake City: P.O. Box 705, Phone 6-1559
Canada, British Columbia, Vancouver: Credit Foncier Bldg., Marine 4918
Canada, Ontario, Toronto: 220 Bay St., EMpire 3-8836

DRAVO CORP.

Neville Island, Pittsburgh 25, Pa.

DUFF-NORTON CO.

2709 Preble Ave., Pittsburgh 30, Pa.

This BUYERS' GUIDE Is Right-Up-to-the-Minute

The Buying Directory Section in this Guidebook is the most comprehensive listing of manufacturers available in the industry. Product listings are based on information obtained from all known manufacturers serving the field—a company-by-company check conducted by the COAL AGE editors just for this 1957 edition.

Manufacturers advertising in this issue appear in bold-face type in the Buying Directory. Their district sales offices and distributors near you are listed in this Distributors' Index. You'll find more helpful product information in their advertisements.

COAL AGE's MINING GUIDEBOOK AND BUYING DIRECTORY ISSUE is an established annual service for all COAL AGE subscribers.

E

EIMCO CORP., THE

Salt Lake City 10, Utah

DISTRICT SALES OFFICES

Alabama, Birmingham: 3140 Fayette Ave.
Idaho, Kellogg: 307 Division St.
Illinois, Chicago: 301 S. Hicks Rd., Palatine
New York, New York: 51-52 South St.
Ohio, Cleveland: 334 Union Building
Pennsylvania, Pittsburgh: 666 Washington Rd
Texas, El Paso: Mills Bldg.
Texas, Houston: 5419 Sanford Rd., Bellaire
Washington, Seattle: 208 Hoge Bldg.

ENTERPRISE WHEEL & CAR CORP.

Bristol, Va.

DISTRICT SALES OFFICES

West Virginia, Huntington: Camden Rd., Phone 20343
West Virginia, Bluefield: P.O. Box 182, Davenport 7-6640

DISTRIBUTOR

Alabama, Homewood: L. D. Brooks, P.O. Box 5725, Tremont 1-7418

EXIDE INDUSTRIAL DIV., ELECTRIC STORAGE BATTERY CO.

42 S. 15th St., Philadelphia 2, Pa.

DISTRICT SALES OFFICES

Alabama, Birmingham 9: 1925 29th Ave. S., TRemont 9-5321
Colorado, Denver 2: 234 Commonwealth Bldg., MAin 3-7793
District of Columbia, Washington 6: 1819 "L" St., N.W., NAtional 8-0800
Georgia, Atlanta 10: 1246 Allene Ave. S.W., PLaza 8-2621
Illinois, Chicago 9: 5335 S. Western Blvd. WAlbrook 5-9800
Illinois, Peoria: 423 1st Nat'l Bank Bldg., Phone 4-5051
Indiana, Indianapolis 4: 325 Bankers Trust Bldg., MElrose 5-6727
Missouri, Kansas City 23: 129 S. Belmont Blvd., BEnton 1-6300
Missouri, St. Louis 8: 3928 Lindell Blvd., OLive 2-1310
New York, New York 36: 25 W. 43d St., BRyant 9-8100
North Carolina, Charlotte 6: 106 N. Caldwell St., FRanklin 5-7966
Ohio, Cincinnati: Rm. 426, 307 E. 4th St., Main 1435
Ohio, Cleveland 14: 1014 Engineers Bldg., Cherry 1-6231
Oregon, Portland 5: 1224 S.W. Morrison St., CApital 2-3778
Pennsylvania, Kingston: 33 Popular St., BUtler 7-8294
Pennsylvania, Philadelphia 4: 101 N. 33d St., EVergreen 2-5858
Pennsylvania, Pittsburgh 16: 1608 Potomac Ave., Fleldbrook 1-2832
Tennessee, Memphis: 902 Dermon Bldg., Jackson 6-5842
Texas, Dallas 1: 2133 McKinney Ave., Riverside 9977
Utah, Salt Lake City 7: P.O. Box 133, Murray Branch, ELgin 9-5766
Washington, Seattle 1: 500 Wall St., Elliott 1377
Washington, Spokane 1: 617 Paulsen Bldg. Madison 4-1295
West Virginia, Charleston: P.O. Box 1562, DIckens 6-8201

F

FALK CORP., THE

Milwaukee, Wis.

DISTRICT SALES OFFICES

Alabama, Birmingham 3: Brown-Marx Bldg., Phone 54-1433
Illinois, Chicago 3: 105 W. Adams St., STate 2-6686
Illinois, Peoria: 800 S. Adams St., Phone 6-0433
Indiana, Indianapolis 8: 3025 N. Illinois Ave. WAlnut 5-7559
Kentucky, Knoxville 17: (Bowditch & Co.), 1311-C N. Broadway, Phone 4-2513
Maryland, Baltimore 12: 4231 Greenmount Ave., TUxedo 9-4969
Missouri, St. Louis 5: 8029 Forsyth Blvd., PArkview 5-8300
New Jersey, Newark 2: 100-102 Parkhurst St., BIgelow 2-5300
Ohio, Akron 9: (B. W. Rogers Co.,) 850 S. High St., HEmlock 4-4181
Ohio, Cincinnati 2: 609 American Bldg., Main 1-2364
Ohio, Cleveland 15: (P. M. Kline & Assocs.), 2036 E. 22nd St., CHerry 1-1171
Ohio, Dayton 2: 410 W. 1st St., BAldwin 4-4833
Pennsylvania, Pittsburgh 19: 410 Grant Bldg., ATlantic 1-1139
Pennsylvania, Upper Darby: 205 Long Lane, FLanders 2-5014
Virginia, Richmond 19: (Williamson & Wilmer), 617 Mutual Bldg., Phone 3-9003
West Virginia, Charleston 2: 3145 Washington St. W., RIverside 4-1821
West Virginia, Fairmont: 801 Coleman Ave., Phone 3453

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Kentucky, Madisonville: National Mine Service Co.
Pennsylvania, Forty Fort: National Mine Service Co.
Pennsylvania, Indiana: National Mine Service Co.
Pennsylvania, Pittsburgh: National Mine Service Co., 564 Alcoa Bldg.
Utah, Salt Lake City: Industrial Physics & Electronics Co.
West Virginia, Beckley: National Mine Service Co.
West Virginia, Logan: National Mine Service Co.
West Virginia, Morgantown: National Mine Service Co.

FLOOD CITY BRASS & ELECTRIC CO.

Messenger & Elder Streets, Johnstown, Pa., Phone 8-1281

SALES AGENTS

Alabama, Birmingham 1: Salmon & Company Inc., P.O. Box 2388
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FOSTER CO., L. B.

P.O. Box 1647, Pittsburgh 30, Pa., WAlnut 1-3300

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Georgia, Atlanta 8: 795 Peachtree St., N.E., TRinity 5-7311
Illinois, Chicago 4: 231 S. La Salle St., CEntral 6-6757
New York, New York 7: Park Murray Bldg., BArclay 7-2109
Texas, Houston 2: Bank of the Southwest Bldg., CApital 7-4301

FUEL PROCESS CO.

900 D St., South Charleston, W. Va.

G

GENERAL ELECTRIC CO., APPARATUS SALES DIV.

1 River Rd., Schenectady 5, N. Y.

GRAYBAR ELECTRIC CO., INC.

420 Lexington Ave., New York 17, N.Y.

DISTRICT SALES OFFICES

Alabama, Birmingham 4: 709 1st Ave. N., Birmingham 4-1861
Alabama, Mobile: 701 N. Joachim St., Hemlock 2-3511
Colorado, Denver 4: 104 Wazee Market, Tabor 5-7116
Georgia, Atlanta 2: 333 N. Ave N. W., Jackson 3-1751
Illinois, Chicago 7: 850 N. Jackson Blvd., Canal 6-4100
Illinois, Peoria 2: 704 S. Adams St., Peoria 6-0765
Illinois, Springfield: 405 N. MacArthur Blvd., Springfield 8-0484
Indiana, Evansville 14: 1709 E. Columbia St., Greenleaf 6-1357
Indiana, Hammond: 6445 Indianapolis Blvd., Tilden 4-7800
Indiana, Indianapolis 2: 1300 W. 16th St., Melrose 8-2351
Kentucky, Louisville 8: 624 Myrtle St., Melrose 7-5411
Maryland, Baltimore 2: 100 S. St., Saratoga 7-5050
Missouri, Kansas City 8: 1644 Baltimore Ave., Baltimore 1-1644
Missouri, St. Louis 10: 600 S. Taylor Ave., Jefferson 1-4700
Missouri, Springfield: 524 St. Louis St., Springfield 2-0587
Oklahoma, Oklahoma City 2: 12 E. California St., Forest 5-9351.
Oklahoma, Tulsa 4: 2406 E. 12th St., Madison 6-2121
Ohio, Cincinnati 10: 115 W. McMickey Ave., Main 1-0600
Ohio, Columbus 15: 3d & Chestnut Sts., Capitol 8-3811
Ohio, Dayton 1: 332 W. Monument Ave., Michigan 5665
Ohio, Portsmouth: 923 Washington St., Portsmouth 3-1766
Oregon, Eugene: 2180 6th Ave. W., Diamond 4-2224
Pennsylvania, Allentown: 1941 Hamilton St., Hemlock 4-9341
Pennsylvania, Erie: 204 W. 6th St. , Erie 2-2221
Pennsylvania, Harrisburg: 1039 S. 13th St., Cedar 8-7303
Pennsylvania, Philadelphia 7: 910 Cherry St., Walnut 2-5405
Pennsylvania, Reading: 22 S. 3d St., Reading 6-1581
Tennessee, Bristol: 536 Anderson St., South 4415
Tennessee, Chattanooga 4: 210 N. Highland Pk. Ave., Chattanooga 4-3357
Tennessee, Knoxville 30: Henly St. & Union Ave., KNoxville 3-6171
Tennessee, Memphis 4: 1474 Lamar Ave., Broadway 8-7150
Tennessee, Nashville 3: 125 16th Ave. N., Alpine 4-6501
Texas, Dallas 1: 717 Latimer St., Randolph 6452
Texas, Fort Worth 7: 104 N. Collins, Arlington 5-3386
Washington, Tacoma 1: 2112 A St., Market 0164
West Virginia, Charleston: 600 Chamber of Commerce Bldg., Kanawha Blvd. & Capitol Sts., Phone 6-0411

GUNDLACH MACHINE CO., T. J., DIV. OF J. M. J. INDUSTRIES

226 Centreville Ave., Belleville, Ill., Adams 3-7208

SALES AGENTS

Colorado, Denver: Clyde E. Clarkson, 4831 E. Harvard Lane, Skyline 6-5277
Illinois, Chicago: Schonthal & Associates, 28 East Jackson Blvd., WAbash 2-8350
Pennsylvania, Greensburg: Andrew M. Gardner, 626 Park Lane, Phone 3350
West Virginia, Huntington 1: Marshall Equipment Co., Box 1367, Phone 3-8691
West Virginia, Wheeling: Richard M. Wilson, 27 Oak Park, Woodale 586

H

H & L TOOTH CO.

1540 South Greenwood Ave., Montebello, Calif.

HARNISCHFEGER CORP., CONSTRUCTION & MINING DIV.

4400 Nat'l Ave., Milwaukee 14, Wis.

HENDRICK MANUFACTURING CO.

Carbondale, Pa.

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New York, New York 7: 30 Church St.
Pennsylvania, Hazleton: Box 315
Pennsylvania, Pittsburgh 8: 6802 Frankstown Ave.

SALES AGENTS

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Missouri, St. Louis: Crandall Ricker Sales Corp., 1169 Paul Brown Bldg.
Ohio, Cleveland 21: Arthur C. Baker, 4062 Mayfield Rd.
West Virginia, Huntington: J. Y. Smythe, 832 Eleventh Ave.

HERCULES POWDER CO., INC.

Wilmington 99, Delaware

DISTRICT SALES OFFICES

Alabama, Birmingham 3: 17 North 20th St., ALpine 2-0293
Illinois, Chicago 4: 332 S. Michigan Ave., HArrison 7-5230
Missouri, Joplin: 404 Main St., MAyfair 4-4138
New York, New York 17: 380 Madison Ave., OXford 7-0010
Pennsylvania, Hazleton: 8 West Broad St., GLadstone 4-0825
Pennsylvania, Pittsburgh 22: 603 Stanwix St., GRant 1-6171
Utah, Salt Lake City 1: 136 S. Main St., EMpire 4-5513

HEWITT-ROBINS, INCORPORATED

Stamford, Conn.

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Arizona, Phoenix: 207-B Camelback Rd., CRestwood 4-0245
Colorado, Denver: 660 Bannock St., AComa 2-8484
Illinois, Chicago: 402 West Randolph St., DEarborn 2-4570
Indiana, Indianapolis: 2813 Questend, S. Dr., WAlnut 4-0577
Kentucky, Louisville: 319 Foeburn Lane, TWinbrook 7-2978
Missouri, St. Louis: 4030 Chouteau Ave., JEfferson 5-8240
New York, New York: 370 Lexington Ave., MUrray Hill 6-2400
North Carolina, Charlotte: 3601 Hutchinson Ave., FRanklin 7-2571
Ohio, Cleveland: 314 Superior Ave. N.E., SUperior 1-8020
Pennsylvania, Ft. Washington: Ft. Washington Industrial Park, MItchell 6-3900
Pennsylvania, Pittsburgh: 951-952 Union Trust Bldg., ATlantic 1-5548
Utah, Salt Lake City: 545 West 8 South St., ELgin 9-8731
West Virginia, Charleston: 4000-B McCorkle Ave. SE, WAlnut 5-2136
West Virginia, Fairmont: Upper Circle, Peacock Park, FAirmont 4883

HEYL & PATTERSON, INC.

55 Fort Pit Blvd., Pittsburgh 22, Pa.

HOYT WIRE CLOTH COMPANY

Abraso St. off Manheim Pike, P.O. Box 22, Lancaster, Pa., EX 4-6871

HUBER-WARCO CO.

Marion, Ohio

DISTRIBUTORS

Illinois, Chicago 29: Gil Boers Equipment Co., 7625 South Kedzie Ave.
Kentucky, Louisville 17: Emmett C. Watson Co., 310 E. Brandeis St.
Missouri, St. Louis 24: Cummings, McGowan & West, Inc., 9100 Olive Street Rd.
Ohio, Cadiz: W. W. Williams Co., 700 Lincoln Ave.
Ohio, Columbus 8: W. W. Williams Co., 835 W. Goodale Blvd.
Ohio, Gallipolis: Bischoff Machinery Co., 300 Fourth Ave.
Pennsylvania, Hazleton: W. N. Dippel, Inc., Route 924, Box 313
Pennsylvania, Pittsburgh 6: Brinker Supply Co., 6545 Hamilton Ave.
Tennessee, Knoxville: Story Brothers, Inc., 4130 Clinton Highway
Tennessee, Nashville: McCarthy, Jones & Woodard, 723 Argyle Ave.
West Virginia, Charleston: Equipment Distributors, Inc., 5528 MacCorkle Ave. S.E

I

INGERSOLL RAND CO.

11 Broadway, New York 4, N.Y.

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Illinois, Chicago 6: 400 W. Madison St., DEarborn 2-4626-35
Missouri, St. Louis 3: 2327 Locust Blvd., GArfield 1-0888
New York, Buffalo 2: 117 W. Chippewa St., CLeveland 6437-8-9
New York, New York 4: 11 Broadway, DIgby 4-6070
Ohio, Cincinnati 6: 428 McGregor Ave., PLaza 1-8060
Ohio, Cleveland 3: 4506 Chester Ave., EXpress 1-9889
Pennsylvania, Philadelphia 3: 2037 Chestnut St., LOcust 7-7535
Pennsylvania, Pittsburgh 22: 932 Penn Ave., ATlantic 1-9070-1-2-3
Pennsylvania, Scranton 9: 315 Walnut St., DIamond 2-8121
Tennessee, Knoxville 24: 412 W. Jackson Ave., Phone 3-3145-6-7
Utah, Salt Lake City 1: 144 S.W. Temple St., DAvis 8-8127
Virginia, Richmond 21: 3431 W. Leigh St., Phone 5-2861

J

JOHNS-MANVILLE CORP.

22 E.40th St., New York 16, N. Y.

DISTRIBUTORS SALES OFFICES

Colorado, Denver 2: 301 Continental Oil Bldg., 1755 Glenarm Pl.
Georgia, Atlanta 3: 101 Marietta St.
Illinois, Chicago 54: Merchandise Mart Plaza
Indiana, Indianapolis 8: 19 West 38th St.
Kentucky, Louisville 7: 131 Breckenridge Lane
Missouri, Kansas City: 2010 McGee St.
Missouri, St. Louis 5: 7912 Bonhomme Ave., Clayton
Ohio, Cincinnati 2: 510 American Bldg., Central Pkwy. at Walnut St.
Ohio, Cleveland 15: 45 Prospect Ave., N.W.
Ohio, Youngstown 12: 6913 Market St.
Oregon, Portland 5: 1220 S.W. Morrison St.
Pennsylvania, Philadelphia 6: The Mall Bldg., Chestnut St. at 4th
Pennsylvania, Pittsburgh 19: 2228 Koppers Bldg.
Pennsylvania, Wilkes-Barre: 742 Miners Bank Bldg., Franklin & Market Sts.
Texas, Houston 1: P.O. Box 255
Utah, Salt Lake City 1: 507 Dooly Bldg., 109 West 2nd South St.
Virginia, Richmond 21: P.O. Box 7215
Washington, Seattle 9: 777 Thomas St.
West Virginia, Charleston 1: 401 Terminal Bldg., Kanawha Blvd. & Capitol St.

JONES & LAUGHLIN STEEL CORP.

3 Gateway Center, Pittsburgh, 30, Pa.

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Illinois, Chicago 3: Field Bldg.
Indiana, Indianapolis 4: Circle Tower Bldg.
Kansas, Kansas City 15: Funston & Chrysler Roads
Kentucky, Louisville 2: Heyburn Bldg.
Missouri, St. Louis 1: Ambassador Bldg.
Ohio, Cincinnati 2: Carew Tower
Ohio, Cleveland 14: Union Commerce Bldg.
Ohio, Columbus 15: LeVeque Lincoln Tower
Pennsylvania, Pittsburgh 30: 3 Gateway Center

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Illinois, Chicago 9: 2250 W. 47th St. (Hammond)
Indiana, Indianapolis: 543 West McCarty St. (W. J. Holliday & Co. Div.)
Kentucky, Louisville 8: 2525 S. 4th St.
Missouri, St. Louis: 1100 Poplar St. (Wire Rope only)
Ohio, Cincinnati 2: 1401 Carew Tower
Ohio, Cleveland: 4721 Gladstone Ave. (Wire Rope only)
Ohio, Cleveland 8: 12875 Taft Ave. (Hamilton Steel Warehouse)
Pennsylvania, Lancaster: Manheim Pike & Steel Way
Pennsylvania, Philadelphia 47: 701 S. Front St. (Wire Rope only)
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Tennesse, Memphis 1: 1 Auction Ave.
Tennessee, Nashville 10: 1898 Herron Drive, P. O. Box 7054, South Station
Texas, Houston 3: 10 N. Milby St. (Wire Rope only)

JOY MANUFACTURING CO.

Henry W. Oliver Bldg., Pittsburgh 22, Pa.

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Colorado, Denver 2: 1626 Wazee St., KEystone 4-6334

District of Columbia, Washington 6: 1741 K. St., N.W., EXecutive 3-6200

Illinois, Centralia: 5th & Chestnut, Phone 4707

Illinois, Chicago 6: 560 W. Washington Blvd., DEarborn 2-4670

Missouri, St. Louis 10: 1203 Macklind Ave., MIssion 5-6670

Montana, Butte: 24 W. Granite St., Phone 6721

New York, New York 6: 140 Cedar St., COrtlandt 7-6545

Ohio, Cleveland 11: 16141 Puritas Ave., CLearwater 1-9444

Oregon, Portland 9: 1631 N.W. Thurman St., CApital 7-5561

Pennsylvania, Forty Fort: 155 Welles St., BUtler 8-4523

Pennsylvania, Philadelphia 2: 1420 Walnut St. PEnnypacker 5-1414

Pennsylvania, Pittsburgh 13: 4107 Sennott St., MAyflower 1-4661-2

Tennessee, Knoxville 2: 108 W. Main St., Phone 2-4121

Texas, Dallas 20: 7425 Hines Blvd., Fleetwood 7-3949

Utah, Salt Lake City 4: 998 S. Sixth West St., DAvis 2-0481

Washington, Seattle 1: 2411 Western Ave. MUtual 2266

West Virginia, Fairmont: P.O Box 1045, Phone 1740

West Virginia, Huntington: 742 8th Ave., Phone 3-3439

DISTRIBUTORS

Alabama, Birmingham: Crandall Engineering Co., 601 N. 10th St., ALpine 1-9262

Colorado, Denver 2: Schloss & Shubart, 1626 Wazee St., AComa 2-2741

Pennsylvania, Mars: Box 236, National 5-9011

Pennsylvania, Rimersburg: Box No. 289, Phone 113

Pennsylvania, Waynesburg: Morning Side, RD No. 3, Phone 1214Y (Orval Robson) Phone 1076

Pennsylvania, Wilkes-Barre: 29 Carey Ave., Valley 3-8305

Tennessee, Chattanooga 11: 1314 S. Seminole Dr., Phone OXford 8-3021

Utah, Springville: 164 W. 2 S., Hunter 9-5541

West Virginia, Bluefield: Box No. 834, Davenport 7-8376

West Virginia, Morgantown: P.O. Box 1133, Phone 9503

West Virginia, Oak Hill: 368 Kelly Ave., Phone 938

DISTRIBUTORS

Alabama, Birmingham: Salmon & Co., Inc.

Kentucky, Jenkins: National Mine Service Co.

Kentucky, Madisonville: National Mine Service Co.

New Mexico, Carlsbad: Bit Grinding Service Inc.

Pennsylvania, Forty-Fort: National Mine Service Co.

Pennsylvania, Indiana: National Mine Service Co.

Pennsylvania, Latrobe: McGinnis Bros. Bit Service Inc.

Pennsylvania, Washington: Fairmont Supply Co.

Virginia, Andover: Central Supply Service of Virginia, Inc.

Virginia, McClure: Erwin Supply & Hardware Co.

West Virginia, Beckley: National Mine Service Co.

West Virginia, Cowen: Pennsylvania & West Virginia Supply Corp.

West Virginia, Fairmont: Fairmont Supply Co.

West Virginia, Logan: National Mine Service Co.

West Virginia, Morgantown: National Mine Service Co.
Pennsylvania & West Virginia Supply Corp.

West Virginia, Shinnston: Erwin Supply Co.

West Virginia, Triadelphia: Pennsylvania & West Virginia Supply Corp.

K

KENNAMETAL INC., MINING TOOL DIV.

Bedford, Pa., Phone 755

DISTRICT SALES OFFICES

Illinois, Benton: 1307 N. Main St., Phone 8-8811

Indiana, Vincennes: 224 Wilbur St., Phone 3299

Kentucky, Barbourville: 419 S. Main St., Box 337, Phone 321

Ohio, Crooksville: 303 Walnut St., Phone 410-S

Pennsylvania, Blairsville: R. D. #3, Phone 944

Pennsylvania, Cadogan: Ford City 62-9964

Pennsylvania, Glenshaw: 107 Orchard Ave., Hunter 6-5722

Pennsylvania, Latrobe: 215 Loyalhanna Ave., KEystone 7-4333

KOPPERS COMPANY, INC., WOOD PRESERVING DIV.

750 Koppers Bldg., Pittsburgh 19, Pa., Express 1-3300

DISTRICT SALES OFFICES

Alabama, Montgomery: P.O. Box 1368, Phone 3-3416

Ohio, Marietta: 102 Front St., Phone Frontier 3-6437

Pennsylvania, Haverford: P.O. Box 389, 355-E, Lancaster Ave., Midway 2-5854

Pennsylvania, Pittsburgh: Peoples First National Bank Bldg., Smithfield & 7th Streets, Express 1-3300

L

LEMAN MACHINE CO.

Post Office Box 236, Portage, Pa.

LE ROI DIV., WESTINGHOUSE AIR BRAKE CO.

Milwaukee 1, Wis.

DISTRICT SALES OFFICES

Colorado, Denver: 610 Farmers Union Bldg., AMherst 6-1042

Georgia, Atlanta: 1621 Chandler Bldg., JAckson 4-3868

New York, New York: 45 Rockefeller Plaza, JUdson 6-2300

Ohio, Cleveland: 235 Brookpark Rd., SHadyside 9-1353

Oklahoma, Tulsa: 5000 45th W. Ave., HIckory 6-6113

DISTRIBUTORS

Alabama, Birmingham: Equipment Service, Inc., 617 N. 9th St., Phone 54-4439

Arizona, Phoenix: Equipment Sales Co., 720 S. 19th Ave., Phone ALpine 8-7151

Colorado, Denver: Denver Air Machinery Co., 1409 Blake St., AM 6-0507

Colorado, Grand Junction: S & M Supply Co., 735 4th Ave., Phone CHappel 3-2032

Indiana, Evansville: Austin Powder Co., Phone HArrison 4-8275

Kentucky, Lexington: Bogie Equipment Co., 801 E. 3d St., Phone 2-3464

Kentucky, Louisville: Bogie Equipment Co., 4397 Poplar Level Rd., GLendale 8-3254

Kentucky, Madisonville: Bogie Equipment Co., Rte. U.S. 41 N., Phone 2740

New Mexico, Albuquerque: Lively Equipment Co., 2601-4th St., N. W., Phone 4-3411

Pennsylvania, Harrisburg: Stewart Equipment Co., 27th & Paxton Sts., CEdar 4-5943

Pennsylvania, Philadelphia: Stewart Equipment Co., 52d & Woodland Ave., SAratoga 7-1611

Pennsylvania, Pittsburgh: A. T. Green Machinery Co., Rte. 8, Glenshaw, STerling 1-9600

Pennsylvania, Wilkes-Barre: Stewart Equipment Co., 251 Kidder St., Valley 4-3151

West Virginia, Clarksburg: West Virginia Mine Supply Co., 212 Ohio Ave., Phone 4-7491

West Virginia, Morgantown: Acme Machinery Co., P.O. Box 631, Phone 5633

West Virginia, South Charleston: R. C. Call, Inc., MacCorkle Ave., POplar 8-1253

West Virginia, Williamson: Acme Machinery Co., P.O. Box 1169, Phone 2274

LINATEX CORP. OF AMERICA

Vernon Ave., Rockville, Conn.; or Wilkins Linatex, Ltd., 1975 Bois Franc Rd., St. Laurent, Quebec, Canada

LINCOLN ENGINEERING CO., DIV. of the McNEIL MACHINE & ENGINEERING CO.

St. Louis 20, Mo.

FACTORY SALES OFFICES

Illinois, Chicago 16: Lincoln Engineering Co. of Ill., 2415 South Michigan Ave., CA 5-6022

Ohio, Cleveland 3: Lincoln Lubricating Systems, Inc., 4500 Euclid Ave., EXpress 1-4334

Oregon, Portland 14: Lincoln Engineering Co. of Calif., 1018 S.E. 8th Ave., BElmont 4-7469
Pennsylvania, Philadelphia 3: Lincoln Engineering Co., Div. of the McNeil Machine and Engr. Co., 1609 Vine St., RIttenhouse 6-8131
Pennsylvania, Pittsburgh: Lincoln Engineering Co., Div. of the McNeil Machine and Engr. Co., 134-36 South Whitfield, MOntrose 1-1444
Canada, Toronto 2-B, Ontario: Lincoln Engineering Co. (Canada) Ltd., 81 John St., EMpire 4-8040
Texas, Ft. Worth 7: Fritz Keller, P.O. Box 9008, Sunset 5451

LINK-BELT COMPANY

Dept. CAMGL-57, Prudential Plaza, Chicago 1, Ill.

DISTRICT SALES OFFICES

Alabama, Birmingham 9: 321 Oxmoor Rd., TRemont 1-1101
Colorado, Denver: Schloss & Shubart, 1626 Wazee St., AComa 2-2741
Illinois, Chicago 9: 300 W. Pershing Rd., BOulevard 8-8100
Illinois, Chicago 9: 301 W. Pershing Rd., ATlantic 5-4401
Indiana, Indianapolis 6: 220 S. Belmont Ave., MElrose 2-5411
Kentucky, Louisville 8: 235 E. Burnett Street, MElrose 7-3668
Michigan, Detroit 4: 5938 Lindsdale Ave., TYler 4-1100
Missouri, Kansas City 8: 2630 Holmes Street, VIctor 2-9234
Missouri, St. Louis 1: 317 N. 11th Street, CHestnut 1-1777
Ohio, Cleveland 20: 3592 Lee Road, WYoming 1-0380
Pennsylvania, Pittsburgh 13: 5020 Centre Avenue, MUseum 1-0600
Washington, Seattle 4: 3405 Sixth Avenue, S. SEneca 8200
West Virginia, Huntington 1: 1009 Fifth Ave., P.O. Box 510, Phone 3-9401
Canada, Scarboro (Toronto 13) Ont.: 1960 Eglinton Ave., P.O. Box 173 Station H, PLymouth 5-4141
South Africa, Springs: P.O. Box 287, Industry Rd., New Era Springs, Phone 56-4136

LONG COMPANY, THE

Oak Hill, W. Va., Telephone 1191

DISTRICT SALES OFFICES

West Virginia, Morgantown: Howard B. Jones, 389 Birch Street, Tel. 4556
Tennessee, Harrogate: W. B. Sweazy, Phone Cumberland Gap, Va. 2862

LUDLOW-SAYLOR WIRE CLOTH CO.

634 S. Newstead Ave., St. Louis 10, Mo., FRanklin 1-0636

DISTRICT SALES OFFICES

Alabama, Birmingham: 1727 6th Ave. N., ALpine 2-5151
California, Los Angeles 65: (Star Wire Screen & Iron Works, Inc.), 2515 San Fernando Rd., CApitol 5-4101
Colorado, Denver: 1530 Carr St., BElmont 3-5421
Illinois, Chicago: 5807 W. Diversey Ave., NAtional 2-1147
Pennsylvania, Pittsburgh: Union Trust Bldg., ATlantic 1-2262
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M

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Illinois, Chicago: 33rd St. & Wentworth Ave., CAlumet 5-5405
Indiana, Indianapolis: 1810 W. 16th St., MElrose 7-3424
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Missouri, Kansas City: 1116 Campbell St., BAltimore 1-4155
Missouri, St. Louis: Chouteau Ave. at Jefferson, PRospect 1-3180
North Carolina, Charlotte: 228 Dalton Ave., P.O. Box 1967, FRanklin 5-2571-2-3
Ohio, Akron: 1100 Triplett Blvd., P.O. Box 7027 S.A.S., PArkway 4-1241
Ohio, Cincinnati: 1223 W. 8th St., CHerry 1-6200
Ohio, Cleveland: 13600 Broadway, LUdlow 1-3300
Oklahoma, Oklahoma City: 1816 Northeast 10th St., P.O. Box 1941, FOrest 5-8496
Oregon, Portland: 1122 No. Williams Ave., BElmont 2-4187
Pennsylvania, Allentown: 727 Union Blvd., P.O. Box 695, HEmlock 4-9371
Pennsylvania, Erie: 960 West 12th St., ERie 424-75
Pennsylvania, Harrisburg: 2020 Paxton St., CEdar 8-8114
Pennsylvania, Philadelphia: 2647 East York St., REgent 9-2777
Pennsylvania, Pittsburgh: 728 Shore Ave., ALlegheny 1-9000-1-2-3-4
Texas, Dallas: 901 So. Akard St., P.O. Box 1528, RIverside 1-5454
Texas, Fort Worth: 2812 North Main St., MArket 6-5451
Utah, Salt Lake City: 704 South Third, West, DAvis 2-3471
Virginia, Richmond: 1705 Ninth Street Rd., RIchmond 83-5467
Washington, Seattle: 3707 Airport Way, SEneca 0860
West Virginia, Charleston: 5800 McCorkle Ave., S.E., WAlnut 5-2161
Canada, Montreal, Quebec: Mack Trucks of Canada, Ltd., 2150 Cote de Liesse Rd., RIverside 8-7801
Canada, Toronto, Ontario: Mack Trucks of Canada, Ltd., 45 Strachan Ave., EMpire 4-0427
Canada, Winnipeg, Manitoba: Mack Trucks of Canada, Ltd., 301 Princess St., WInnipeg 93-0555
Washington, D. C.: 2121 W. Virginia Ave., N.E., LAwrence 6-9060

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A complete index to the advertisers in this Guidebook issue appears on page 368. If you're looking for useful product information, be sure to check the manufacturers' advertising first.

MANITOWOC ENGINEERING CORP.

S. 16th St., Manitowoc, Wis., MUrray 4-6621

DISTRIBUTORS

Indiana, Evansville 14: Manitowoc Eng. Corp., 1222 Lincoln Ave., Harrison 30398
Ohio, Columbus 8: W. W. Williams Co., The, 835 W. Goodale Blvd., Capital 8-6651
Pennsylvania, Bridgeville: Anderson Equipment Co., P.O. Box 427, Lehigh 1-6020 or Bridgeville 262

MARTINDALE ELECTRIC CO.

1307 Hird Ave., Cleveland 7, Ohio

McLANAHAN & STONE CORP.

Hollidaysburg, Pa., Phone 5-9807

McNALLY-PITTSBURG MFG. CO.

307 W. 3d St., Pittsburg, Kansas, Phone 542

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Brazil, Rio de Janeiro: Formac, S.A., Caixa Postal, 1310

MERRICK SCALE MFG. CO.

184 Autumn St., Passaic, N. J.

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Pennsylvania, Pittsburgh 22: E. F. Morgan Co., Rm. 1526, Farmers Bank Bldg., Atlantic 1-1564
Tennessee, Chattanooga 2: Edgar A. Rogers, Chattanooga Bank Bldg., Chattanooga 7-4640
Canada, Ontario, Toronto 9: Dominion Flow Meter Co., Ltd., P.O. Box 69, Station D, Murray 8285

MINE SAFETY APPLIANCES CO.

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Kentucky, Madisonville: P.O. Box 542, Phone 2680
Kentucky, Pikeville: Hatcher Hotel Bldg., Phone 748
Missouri, St. Louis 3: 1915 Washington Ave., MAin 1-2251
Montana, Butte: 2419 Princeton Ave., Phone 6875
Ohio, St. Clairsville: 257 E. Main St., Phone 565
Pennsylvania, Ebensburg: 729 W. Highland Ave., Phone 756

Continued

MINE SAFETY . . . Cont'd

Pennsylvania, Indiana: 241 Elm St., Phone 3-8850
Pennsylvania, Johnstown: 610 Johnstown Bank & Trust Bldg., Phone 8-2811
Pennsylvania, Pittsburgh 8: 7519 Penn Ave., Churchill 1-5900
Pennsylvania, Uniontown: 624 Fayette Nat. Bank Bldg., Geneva 8-7351
Pennsylvania, Wilkes-Barre: 66 Carverton Rd. (Trucksville), Dallas 4-5381
Utah, Salt Lake City 1: 257 Rio Grande St., Empire 4-6044
Virginia, Norton: 840 Park Ave., Phone 888
West Virginia, Bluefield: 1513 Bluefield Ave., Davenport 5-8866
West Virginia, Clarksburg: 117 Forest Ave., Main 2-3101
West Virginia, Fairmont: 1313 Peacock Lane, Phone 909
West Virginia, Logan: P.O. Box 1306, Phone 1607
West Virginia, Williamson: 38 Sunset Blvd., Phone 1074
Canada, Calgary, Alberta: 3632 Burnsland Rd., Chestnut 3-4092
Canada, Nova Scotia, Sydney: 150 Charlotte St., Phone 8370
Canada, Ontario, Toronto 4: 500 MacPherson Ave., Walnut 5-1101
Canada, Vancouver, B. C.: 3754 W. Tenth Ave., Alma 1127

MINERS' HARDWARE SUPPLY CO.

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MORRIS MACHINE WORKS

Baldwinsville, N. Y.

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Maryland, Baltimore 18: Jobe & Co., 344 E. 33d St., BE 5-3503 & 5-5033
Missouri, Kansas City 5: Lee Mathews Machinery & Rental Co., 318 Broadway, Baltimore 1-0650
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Pennsylvania, Pittsburgh 22: Ramsay Pump & Supply Co., 1701-3 Keenan Bldg., CO 1-1155-6
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Tennessee, Chattanooga 2: Edgar A. Rogers, Chattanooga Bank Bldg., AM 7-4640
Texas, Houston 1: Alliger & Sears Co., 2203 Fannin (Box 2217), CA 4-6933
Utah, Salt Lake City 10: Lang Co., 1st S. & 2d West, Phone 3-5831
Virginia, Richmond 19: O'Neil Pump & Engineering Co., 601 E. Franklin St., Phone 7-4828
Washington, Seattle 4: Olympic Supply Co., 1743 1st Ave., S., Seneca 0416
West Virginia, Charleston: Cross Pump & Equipment Co., 2853 Piedmont Rd., WAlnut 5-5822
Canada, British Columbia, Vancouver: A. B. Wing Ltd., 1383 Hornsby St., Tatlow 7531
Canada, Quebec, Montreal: F. H. Hopkins & Co., Ltd., 8500 Decarie Blvd. Phone 21-7-4737

MYERS-WHALEY CO.

P. O. Box 789, Knoxville 1, Tenn.

N

NACHOD & UNITED STATES SIGNAL CO.

4771 Louisville Ave., Louisville 9, Ky., EMerson 3-3571

NATIONAL MALLEABLE & STEEL CASTING CO.

10600 Quincy Ave., Cleveland 6, Ohio

NOLAN CO., THE

Bowerston, Ohio, Phone 6-2771

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Pennsylvania, Pittsburgh: George C. Hutchinson, Jr., 1304 Keenan Bldg., Atlantic 1-5860
Pennsylvania, Wilkes-Barre: John Lloyd & Sons, 33 Bennett Bldg., Valley 4-4691
Utah, Castle Gate: Frank C. Memmott, P. O. Box 154
West Virginia, Huntington: Huntington Supply & Equip. Co., Huntington National Bank Bldg., Phone 2-5562

NORBERG MFG. CO.

3073 S. Chase Ave., Milwaukee 1, Wis., SHeridan 4-2370

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New York, New York 17: 60 E. 42d St., MUrray Hill 7-7666

P

PARIS MFG. CO.

Paris, Ill., Paris 3-7280

PROTO TOOL CO.

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R

REICH BROS. MFG. CO.

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California, Canoga Park: 19840 Sherman Way, DIamond 8-8339
Florida, Ft. Lauderdale: 2631 Grace Drive, JAckson 4-7759
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Pennsylvania, Hazleton: Frank L. Swabb Eqpt. Co., Hazleton Nat'l Bank Bldg.
Washington, Spokane: Western Machinery Co., 808 N. Division St., FAirfax 2-1501
West Virginia, Charleston: Machinery Inc., 2855 Piedmont Rd.
Canada, Toronto, Ont.: Ray-Gordon, Ltd., 1385 Bloor St., West, KEnwood 9471

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130 N. Wells St., Chicago 6, Ill., CEntral 6-7292

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Rome, N. Y.

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Pennsylvania, Pittsburgh: Mosebach Electric Supply Co., 1115 Arlington Ave.
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West Virginia, Beckley: Anchor Sales Co., P.O. Box 210
West Virginia, Bluefield: Bluefield Supply Co., 100 Mercer St.
West Virginia, Charleston: Virginia Electric, Inc.
West Virginia, Cowen: Pa. & W. Va. Supply Corp.
West Virginia, Elm Grove: Pa. & W. Va. Supply Corp.

West Virginia, Fairmont: Fairmont Supply Co., 10th & Beltline
West Virginia, Morgantown: Pa. & W. Va. Supply Corp.
West Virginia, Wheeling: Pa. & W. Va. Supply Corp., Box 871

RUBEROID CO.

500 5th Ave., New York 18, New York

S

SALEM TOOL CO., THE

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Arkansas, Little Rock: R. A. Young & Son, Inc., 301 S. 10th St.
Colorado, Denver 16: Union Supply Co., 5460 Colorado Blvd.
Illinois, Mt. Vernon: Ed. Meyer Tractor Co.
Indiana, Evansville: Austin Powder Co., Box 177
Iowa, Des Moines: Herman M. Brown Co., First & Sheridan
Kansas, Pittsburg: W. A. Thomas Supply Co., 112-114 W. Pacific
Kentucky, Lexington 6: Wilson Machinery & Supply, 561 W. 4th St.
New York, New York 6: Exdevco Corp., 19 Rector St.
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Ohio, Cleveland 29: Rish Equipment Co., P.O. Box 7303
Ohio, Columbus 11: Rish Equipment Co., P.O. Box 6398, Oakland Park Branch
Ohio, Dayton 9: Rish Equipment Co., P.O. Box 543
Ohio, Portsmouth: Rish Equipment Co., P.O. Box 270
Ohio, Steubenville: Voto Mfg. & Sales Co., 525 N. Webster
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Virginia, Roanoke: Rish Equipment Co., P.O. Box 1369
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West Virginia, Clarksburg: Rish Equipment Co., P.O .Box 2227
West Virginia, Parkersburg: Rish Equipment Co., P.O. Box 1728

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New York, New York 6: Room 807, 90 West St., COrtlandt 7-0640
Oregon, Portland: 6915 S.W. 68th Ave., CHerry 4-8463
Pennsylvania, Gibsonia: Dickey Rd., R. D. #2, Box 34, HIlltop 2-2550
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West Virginia, Charleston: Machinery Inc., P.O. Box 2911, WAlnut 5-2121
West Virginia, Clarksburg: West Virginia Mine Supply Co., P.O. Box 872, MAine 4-7491
West Virginia, Williamson: Acme Machinery Co., P.O. Box 1169, WIlliamson 2274

SPENCER CHEMICAL CO.

610 Dwight Bldg., Kansas City 5, Mo.

STAMLER CORP., W. R., THE

P.O. Box 79, Paris, Ky., Phone Millersburg 2185

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Utah, Salt Lake City: Western Sales & Engineering Co., 375 S.W. Temple Ave., Davis 24311

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STONHARD COMPANY, INC.

1306 Spring Garden St., Philadelphia 23, Pa.

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Missouri, St. Joseph: 920 South Sixth St., Phone 4-0855
Missouri, St. Louis: 3545 Lindell Blvd., OLive 2-7675
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Ohio, Cleveland: 1138 Schofield Bldg., SUperior 1-4144
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Virginia, Richmond: 1 North Sixth St., RIchmond 3-0772

SUTPHEN, PETER O.

Box 58, Everett, Pa., Phone 39

T

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Broadview, Ill.

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Long-Lewis Hardware Co., 420 N. 9th St.
Moore-Handley Hardware Co., 27 S. 20th St.
Wimberly & Thomas Hardware Co., 1809 Ave. A

Continued

TEMPLETON, KENLY . . . Cont'd

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Lyons Machinery Co., 908 Towson
R. A. Young & Son, Inc., 301 S. 10th St.
Colorado, Denver:
Mine & Smelter Supply Co., 3800 Race St.
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Barrett Christie Co., 108 N. Clinton
Clifford Peterson Tool Co., 123 N. Jefferson St.
Goodman Mfg. Co., 4834 S. Halsted St.
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McMaster-Carr Supply Co., 640 W. Lake St.
Sterling Products Co., Inc., 121 N. Jefferson St.
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Couch & Heyle, 1016 S. Adams
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Vonnegut Hdwe. Co., 402 Maryland St.
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Hardware Supply Co., Inc., 930-940 Chestnut St.
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Mechanical Suppliers, Inc., 100 N. 9th St.
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Kentucky, Greenville: Greenville Supply Co., Box 260
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Kentucky Mine Supply Co., River St.
McComb Supply Co., Inc.
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L. R. Reams Supply Co., P.O. Box 436
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Shapleigh Hardware Co., 900 Spruce St.
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Missouri, Kansas City:
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Victor L. Philips & Co., 1600 Baltimore St.
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Canton Hardware Co., 1221-1227 3d St. N. E.
Canton Supply Co., The, 938 Cleveland Ave. S.W.
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E. A. Kinsey Co., 331 W. 4th St.
Ohio, Cleveland:
Cleveland Tool & Supply Co., 1427 W. 6th St.
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Strong, Carlisle & Hammond Co., 1392 W. 3d St.
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Ohio, Portsmouth: Rish Equipment Co.
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Ohio, Warren:
Bert Clark Co., 1231 Vine Ave., N.E.
Warren Hdwe. Co., P.O. Box 1911
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Marshall Supply & Equipment Co., 1241 W. Main St.
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Marshall Supply & Equipment Co., 920 E. Archer
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Pennsylvania, Greensburg: Westmoreland Hardware Co., 326 Mt. Pleasant St.
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Quaker Sales Corp., P. O. Box 870
Thackray Co., 1036 Broad St.
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Pennsylvania, Philadelphia:
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C. A. Turner Inc., 117 Third Ave.
Frich & Lindsay Co., Sandusky & Robinson Sts.
Harris Pump & Supply Co., Brady & Sidney Sts.
Pittsburgh Gage & Supply Co., P.O. Box 1168
Somer. Filter & Todd Co., 327 Fort Pitt Blvd.
Pennsylvania, Scranton:
Bittenbender Co., 126-132 Franklin Ave.
Pennsylvania, Washington: Fairmont Supply Co., 437 Jefferson Ave.
Pennsylvania, W. Brownsville: Ward Supply Co., Inc.
Pennsylvania, Wilkes-Barre:
Eastern Pennsylvania Supply Co., 56-62 S. Pa. Ave.
Standard Equipment Co., 152 Horton St.
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Tennessee, Johnson City: Summers Hardware & Supply Co.
Tennessee, Knoxville:
C. M. McClung & Co., 501 W. Jackson Ave.
Tennessee Mill & Mine Supply Co., 406 State St.
Tidewater Supply Co., P.O. Box 377
Utah, Salt Lake City:
Industrial Supply Co., Inc., Box 600
Mine & Smelter Supply Co., 121 W. 2d South
Virginia, Andover: Central Supply Co. of Virginia
Virginia, Applachia: Central Supply Co. of Virginia
Virginia, Grundy: Buchanan-Williamson Supply Co., Box 933
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Washington, Seattle:
Campbell Industrial Supply Co., 3433 Airport Way at Spokane St.
The Carrington Co., 91 Columbia St.
Washington, Tacoma: Hunt & Mottet Co., 2112 Pacific Ave.
West Virginia, Beckley:
Anchor Sales Co., 313 Prince St., Box 210
National Mine Service Co.
West Virginia, Bluefield:
Bluefield Hardware Co., 400 Bluefield Ave.
Bluefield Supply Co., P.O. Box 269
Superior Sterling Co., 200 Bluefield Ave.
West Virginia, Charleston:
Capital City Supply Co., 544-522 Broad St., Box 833
McJunkin Corp., P.O. Box 573
Persingers Inc., 520 Elizabeth St., P.O. Box 1866
Rish Equipment Co.
West Virginia, Clarksburg: Rish Equipment Co.
West Virginia, Cowen: Penna. & W. Va. Supply Corp.
West Virginia, Elkins: Valley Supply Co., 11th St. & Railroad Ave.
West Virginia, Elm Grove: Pa. & West Virginia Supply Corp.
West Virginia, Fairmont: Fairmont Supply Co., 10th & Belt Line
West Virginia, Huntington:
Banks-Miller Supply Co., 330 3d Ave.
Ensign Electric Mfg. Co., 914 Adams Ave.
West Virginia, Kermit: Controller Block & Supply Co., Box P
West Virginia, Logan:
Guyan Machinery Co., Inc.
Logan Hardware & Supply Co., 300 Highland Ave.
West Virginia, Morgantown: Pa. & West Virginia Supply Corp., Wall St.
West Virginia, Shinnston: Erwin Supply & Hdwe., Inc., P.O. Box 247
West Virginia, Wheeling: Pa. & West Virginia Supply Corp., P.O. Box 871
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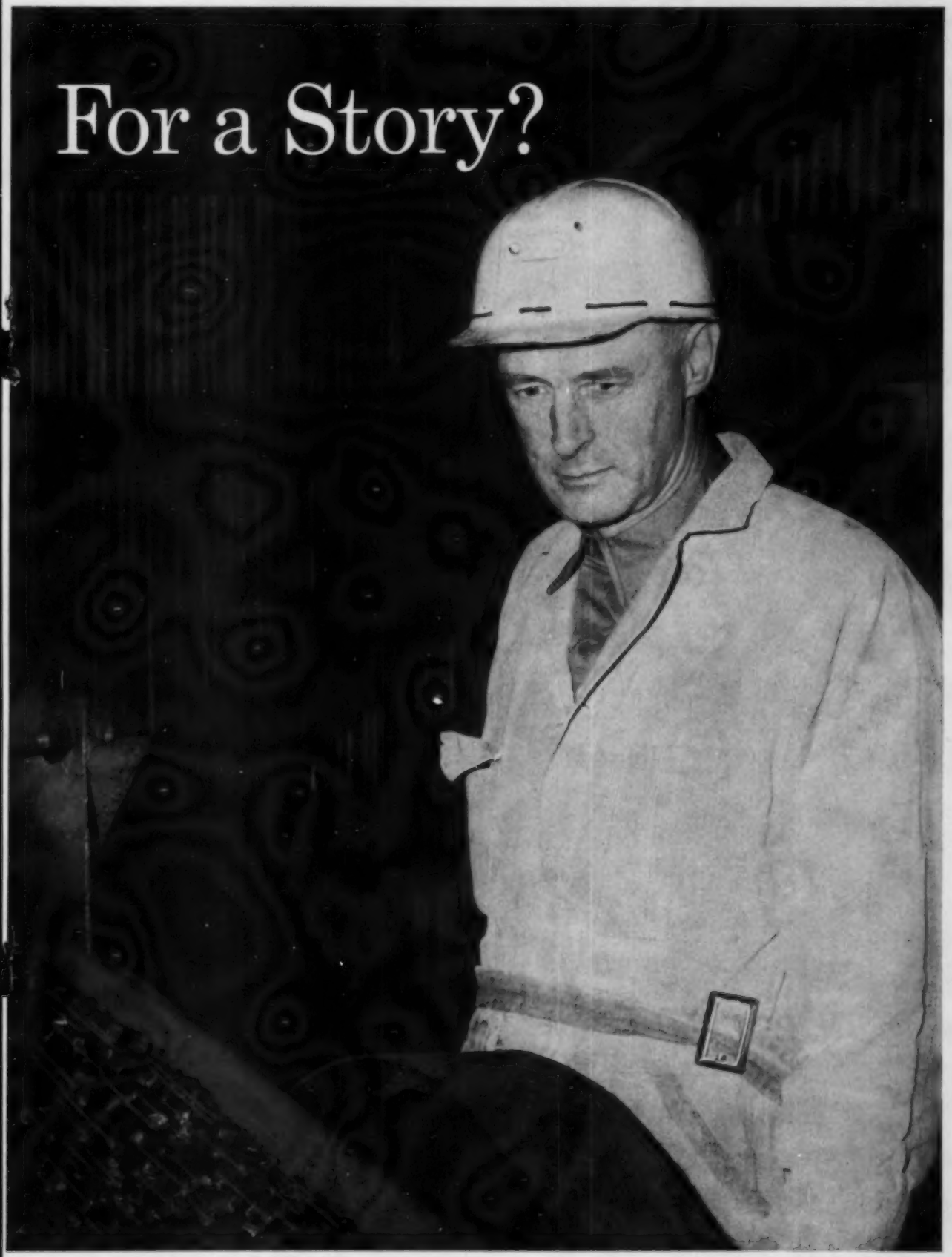

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